TMENT OF COMMERCE
BUREAU OF FISHERIES
HENRY O'MALLEY, Commissioner

PROPAGATION AND DISTRIBUTION OF FOOD FISHES, 1922

REPORT OF THE DIVISION OF FISH CULTURE FOR THE FISCAL YEAR 1922

By GLEN C. LEACH
Assistant in Charge of Fish Culture

APPENDIX XVII TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1922

Bureau of Fisheries Document No. 941

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By GLEN C. LEACH, *Assistant in Charge of Fish Culture.*

CONTENTS.

[1] Appendix XVII to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 941.

INTRODUCTION.

An interesting point in connection with the bureau's fish-cultural activities, and one that augers well for future progress, is the intelligent interest displayed by an ever-increasing number of persons. State officials, persons interested in the commercial fisheries, sportsmen's organizations, officials of the large railroad companies, and many individuals in all parts of the country watch the work with jealous interest, as is made manifest by their frequent comment upon it. Such comments are sometimes commendatory in character, or they may take the form of adverse criticism. In either case they are welcomed as being indicative of an awakening public sentiment

and as a potent factor in stimulating those who are connected with fish culture to continued and greater effort for the advancement of the work.

VALUE OF FISHES OF MINOR INTERIOR WATERS.

It has long been recognized that the commercial fisheries of the country have constituted one of our most valuable national assets, but it is only recently that the fishes of our minor interior waters have come to be considered by the general public as a resource of consequence. The wild life of both land and water is now very generally regarded as a great national asset, so much so that the so-called game birds and other land animals have within recent years been made the subject not only of Federal and State legislation but of international treaty as well. Though perhaps of equal importance, fish have not received the same attention, notwithstanding the fact that the Federal Government has long maintained fish-cultural stations at suitable points in various parts of the country. The monetary value of our commercial fisheries is known with some degree of accuracy from statistics that may be compiled without unusual difficulty. On the other hand, the value of the fishes of inland waters that do not figure in a commercial sense must be based on estimate, owing to the difficulty encountered in securing accurate data. However, enough is known to warrant the statement that the compilation of such data would present an imposing array of figures whose total would be surprisingly large. In support of this statement, the following estimates of the value of fish taken by anglers in three of the States bordering the Great Lakes are of interest. The figures are quoted from an address by the fish commissioner of Minnesota at Milwaukee, in March, 1922. The figures are intended to cover only the actual value of the fish taken by anglers and do not include any value the fish may have had as an incentive to travel, recreation, or indirect worth of any kind; nor do they include any estimate of the amounts contributed by tourists and anglers to the volume of business of railways, hotels, outfitters, and others. It is assumed by the Bureau of Fisheries that the high value placed on this estimated catch is based on retail prices.

Value of fish taken by anglers.

State.	Pounds.	Value.
Wisconsin, 1921	.....	$2,125,000
Minnesota, 1921	7,000,000	3,000,000
Michigan, 1920	2,850,000	1,275,000

The States mentioned are in no wise exceptional in this respect, as the figures presented could be duplicated or even exceeded in other sections of the country. The American public is rapidly acquiring the habit of outing vacations by motor, with a consequent increase in the demand for good fishing in inland waters. To meet this demand, an extension either by the States or the Federal Government of that branch of fish culture dealing with minor interior waters is imperative. Ever since practical fish culture was initiated

by the Federal Government the commercial fishes have received first consideration, and for many years more than 90 per cent of the output of the Federal hatcheries has consisted of such species as are prominent in the great commercial industry, and a large percentage of the funds available for fish culture has been devoted to this part of the work. The wisdom of this policy is not questioned, and there are many opportunities for the continued extension of the bureau's usefulness in this direction. Nevertheless, the time is at hand when the importance of maintaining the fish supply in our minor interior waters can not be overlooked, and any plans for the future extension of our fish-cultural activities must be comprehensive enough to include them.

COOPERATION WITH STATES, OTHER FEDERAL AGENCIES, AND FOREIGN GOVERNMENTS.

Each year there is to be noted an increasing amount of work along fish-cultural lines accomplished in cooperation with the various States. It has long been the policy of the bureau to foster and encourage such cooperation, and the results attained are gratifying. The fiscal year 1922 has found the bureau working in close harmony with 31 States that have thus far taken an active interest in practical fish culture. Such cooperative work has been varied in its nature, involving in some instances joint operations at egg-collecting stations and frequent exchange of eggs of various species for the convenient distribution of the resulting fish.[2] In other cases the bureau has loaned its distribution cars to enable the States quickly and economically to distribute the fish from their hatcheries, the State paying all transportation costs. In still other instances the bureau has been able to incubate in its hatcheries fish eggs purchased or otherwise acquired by States not operating hatcheries, the resulting fry or fingerlings being placed at the disposal of the State officers.

It sometimes happens that the bureau is unable to honor applications received, because it lacks funds for transporting fish to places remote from the points of production. Several States are now paying transportation charges for the bureau's cars to and from the point of production while engaged in distributing fish within their boundaries. In still another instance an agreement has been reached with the fishery authorities of a State whereby the State, as concerns the distribution of fish, has been divided into two parts. Under this agreement all applications for fish emanating north of the dividing line are to be honored by the State, while those from the southern portion are to be taken care of by the bureau. In theory at least this arrangement should result in greater economy and obviate the present duplication of effort.

It is desired to express special appreciation of the courtesies extended by the States of Washington and Oregon, whereby several items of work in which the bureau was interested were carried to

[2] A statement of the numbers and species of fish and fish eggs furnished to States and insular possessions of the United States during the fiscal year 1922 is contained on p. 84.

a point that would have been quite unattainable without such assistance. The bureau is indebted to the State of Montana for its liberal assistance in stocking streams and lakes in the Glacier National Park, Yellowstone National Park, and other waters of that region; to the State of Michigan for supplying considerable numbers of brook trout, rainbow trout, and grayling; and to the State of Maine for assistance rendered in connection with the landlocked salmon work in that State.

The bureau is constantly extending its cooperative relations with other Federal agencies. Because of similar interests along certain lines, which are becoming more generally recognized each year, much practical cooperative work is being accomplished. In this connection the bureau is indebted to officers of the United States Forest Service for the construction of trails in Alaska, for furnishing horses or other means of conveyance for the transportation of persons on trips of investigation, for the movement of supplies to field stations, and for carrying fish and fish eggs for stocking waters of our national forests in the New England States and other parts of the country. Officers of the National Park Service have rendered similar valuable assistance in the Glacier and Yellowstone National Parks and in the construction of a log hatchery on Fish Lake, near Soda Butte, on the latter reservation. The Reclamation Service has also been of assistance in furnishing transportation facilities in the movement of fish supplied for stocking waters within its control. Of particular interest and importance is the fact that these agencies have facilities for transporting fish to points that are not readily accessible by the ordinary methods.

The amicable fish-cultural relations that have heretofore existed between the bureau and the Canadian Government have been maintained. Spawn takers employed by the bureau have continued to collect eggs of the whitefish and cisco in Canadian waters, and eggs of other species have been exchanged. Shipments of fish eggs have been made to other foreign governments also, all of which are listed in the table on page 88.

SENTIMENT IN FAVOR OF FISH PROTECTION.

In view of the active interest the bureau has taken in urging the adoption of adequate protective laws for the food fishes of the country, it is a source of gratification to note a more active interest in this direction on the part of certain States. In the course of the year a number of the Southern States, which have heretofore paid little or no attention to the matter, have sought the aid and advice of the bureau in framing laws for fish protection or in connection with the establishment of hatcheries for the propagation of the fishes suited to their needs. Believing in the truth of the old saying, that "No law is stronger than the public sentiment behind it," the bureau has adhered to a policy of urging on the attention of all persons applying for fish the desirability and urgent need for protective laws and a proper respect therefor.

Part 1.—FISH PRODUCTION: PROPAGATION AND RESCUE WORK.

TABULAR SUMMARIES OF OPERATIONS.

SPECIES OF FISHES HANDLED.

The work as conducted during the fiscal year ended June 30, 1922, involved 54 species of fish, as indicated in the accompanying list, each species listed being the subject either of artificial propagation or rescue work:

LIST OF SPECIES HANDLED.

THE CATFISHES (SILURIDÆ):
- Horned pout, bullhead (*Ameiurus nebulosus*).
- Marbled catfish (*Ameiurus nebulosus marmoratus*).
- Mississippi catfish (*Ameiurus lacustris*).
- Spotted catfish, channel catfish (*Ictalurus punctatus*).
- Yellow catfish (*Leptops olivaris*).

THE SUCKERS (CATOSTOMIDÆ):
- Mongrel buffalo fish (*Ictiobus urus*).
- Common buffalo fish (*Ictiobus cyprinella*).
- Small-mouthed buffalo fish (*Ictiobus bubalus*).

THE CARPS (CYPRINIDÆ):
- Asiatic carp (*Cyprinus carpio*).

THE SHADS AND HERRINGS (CLUPEIDÆ):
- Shad (*Alosa sapidissima*).
- Glut herring (*Pomolobus æstivalis*).
- Skipjack (*Pomolobus chrysochloris*).

THE SALMONS, TROUTS, WHITEFISHES, ETC. (SALMONIDÆ):
- Common whitefishes (*Coregonus albus* and *C. clupeaformis*).
- Cisco (chiefly *Leucichthys artedi*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tschawytscha*).
- Chum salmon, dog salmon (*Oncorhynchus keta*).
- Humpbacked salmon, pink salmon (*Oncorhynchus gorbuscha*).
- Silver salmon, coho salmon (*Oncorhynchus kisutch*).
- Sockeye salmon, blueback salmon, redfish (*Oncorhynchus nerka*).
- Steelhead salmon (*Salmo gairdneri*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Rainbow trout (*Salmo shasta*).
- Black-spotted trout, redthroat trout (*Salmo lewisi*).
- Loch Leven trout (*Salmo levenensis*).
- Lake trout, Mackinaw trout (*Cristivomer namaycush*).
- Brook trout (*Salvelinus fontinalis*).

THE GRAYLINGS (THYMALLIDÆ):
- Montana grayling (*Thymallus montanus*).

THE SMELTS (OSMERIDÆ):
- Smelt (*Osmerus mordax*).

THE PIKES (LUCIIDÆ):
- Little pickerel (*Lucius vermiculatus*).
- Common pickerel (*Lucius lucius*).

THE MACKERELS (SCOMBRIDÆ):
- Mackerel (*Scomber scombrus*).

THE SUNFISHES, BLACK BASSES, AND CRAPPIES (CENTRARCHIDÆ):
- Crappies (*Pomoxis annularis* and *P. sparoides*).
- Large-mouthed black bass (*Micropterus salmoides*).
- Small-mouthed black bass (*Micropterus dolomieu*).
- Rock bass (*Ambloplites rupestris*).
- Warmouth bass, goggle-eye (*Chænobryttus gulosus*).
- Bluegill sunfish (*Lepomis pallidus*).
- Common sunfish (*Eupomotis gibbosus*).

THE PERCHES (PERCIDÆ):
Pike perch (*Stizostedion vitreum*).
Yellow perch (*Perca flavescens*).
THE SEA BASSES (SERRANIDÆ):
Striped bass, rockfish (*Roccus lineatus*).
White bass (*Roccus chrysops*).
White perch (*Morone americana*).
Sea bass (*Centropristes striatus*).
THE PORGIES (SPARIDÆ):
Scup, scuppaug (*Stenotomus chrysops*).
THE DRUMS (SCIÆNIDÆ):
Fresh-water drum, lake sheepshead (*Aplodinotus grunniens*).
THE CODS (GADIDÆ):
Cod (*Gadus callarias*).
Haddock (*Melanogrammus æglefinus*).
Pollock (*Pollachius virens*).
THE FLOUNDER (PLEURONECTIDÆ):
Winter flounder, American flatfish (*Pseudopleuronectes americanus*).
Pole flounder (*Glyptocephalus cynoglossus*).

OUTPUT.

The combined work of the fish-cultural stations and the rescue crews during the year resulted in a net output of 5,125,101,320 fish and fish eggs for distribution as compared with 4,962,489,405 for the year previous. Some points of interest to be noted in comparing the appended tables summarizing by species the net outputs for the fiscal years 1922 and 1921 are an increase in the fiscal year 1922 of approximately 50 per cent in the output of fingerling fish and of about 3 per cent in the aggregate output, accomplished with a decrease of about 6 per cent in operating costs. The cost per million of the fish and fish eggs produced during 1922 was $120.36 as against $128.06 per million for 1921. Of the total output for 1922 all but approximately 35,000,000 may properly be classed as of direct commercial importance.

Summary, by species, of net output of fish and fish eggs, fiscal years 1922 and 1921.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
1922				
Catfish			52,137,880	52,137,880
Buffalo fish	86,906,000	51,000,000	3,341,480	141,247,480
Carp		82,050,000	22,006,805	104,056,805
Shad		63,461,200		63,461,200
Glut herring		82,600,000		82,600,000
Whitefish	156,242,000	306,350,000		462,592,000
Cisco	220,690,000	47,400,000		268,090,000
Chinook salmon	1,400,000	1,311,550	57,769,870	60,481,420
Chum salmon		1,540,000	14,027,610	15,567,610
Humpbacked salmon		369,860	1,119,400	1,489,260
Silver salmon		600,000	11,074,940	11,674,940
Steelhead salmon	450,000	20,000	2,028,220	2,498,220
Sockeye salmon	150,000	32,600,000	59,522,365	92,272,365
Atlantic salmon		1,334,000	180	1,334,180
Landlocked salmon	115,000	187,230	95,780	398,010
Rainbow trout	21,377,840	410,700	4,439,685	7,228,225
Black-spotted trout	1,097,500	493,400	931,000	2,521,900
Loch Leven trout			56,000	56,000
Lake trout	2,796,000	29,359,365	213,090	32,368,455
Brook trout	255,000	3,019,050	6,717,805	9,991,855
Grayling		250,000		250,000
Smelt		300,000		300,000
Pike and pickerel			679,795	679,795

Summary, by species, of net output of fish and fish eggs, etc.—Continued.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
1922				
Mackerel		1,980,000		1,980,000
Crappie			36,468,545	36,468,545
Large-mouthed black bass		281,700	1,652,710	1,934,410
Small-mouthed black bass		568,250	76,990	645,240
Rock bass		800	52,095	52,895
Warmouth bass			2,515	2,515
Sunfish			52,697,985	52,697,985
Pike perch	79,650,000	55,897,500	34,390	135,581,890
Yellow perch	34,400,000	207,527,000	1,604,350	243,531,350
Striped bass		25,530,000		25,530,000
White bass			36,510	36,510
Sea bass		32,000		32,000
Scup		2,505,000		2,505,000
Fresh-water drum			242,025	242,025
Cod	208,224,000	232,131,000		440,355,000
Haddock	75,960,000	290,820,000		366,780,000
Pollock		327,380,000		327,380,000
Winter flounder	193,178,000	1,867,378,000		2,060,556,000
Pole flounder	5,090,000			5,090,000
Miscellaneous fishes			10,402,355	10,402,355
Total	1,068,981,340	3,716,687,605	339,432,375	5,125,101,320
1921.				
Catfish			35,257,070	35,257,070
Buffalo fish		108,307,000	1,645,835	109,952,835
Carp		106,043,000	3,918,580	109,961,580
Shad		32,792,275		32,792,275
Glut herring		43,815,000		43,815,000
Whitefish	181,650,000	238,860,000		420,450,600
Cisco	186,510,000	89,800,000		276,310,000
Chinook salmon	6,780,000		32,780,765	39,560,765
Chum salmon		7,000,000	19,436,400	26,436,400
Silver salmon		600,000	6,486,150	7,086,150
Sockeye salmon	350,000	38,778,500	30,434,500	69,563,000
Steelhead salmon	493,000	38,810	2,928,915	3,460,725
Atlantic salmon		1,387,000	280	1,387,280
Landlocked salmon	575,000	208,115	124,250	907,365
Rainbow trout	2,553,240	414,100	3,872,225	6,839,565
Black-spotted trout	820,000	3,899,100	1,000,300	5,719,400
Loch Leven trout			64,000	64,000
Lake trout	2,824,000	16,563,300	208,500	19,595,800
Brook trout	856,890	3,642,330	7,559,625	12,058,845
Grayling		1,400,000		1,400,000
Smelt	600,000	7,000,000		7,600,000
Pike and pickerel			540,510	540,510
Crappie			37,303,900	37,303,900
Large-mouthed black bass		585,050	1,221,905	1,806,955
Small-mouthed black bass		303,700	54,590	358,290
Rock bass			108,305	108,305
Warmouth bass			100	100
Sunfish			30,371,475	30,371,475
Pike perch	296,475,000	57,385,000	108,515	353,968,515
Yellow perch	12,000,000	176,369,450	6,166,435	194,535,885
Striped bass		20,184,000		20,184,000
White bass			27,170	27,170
Fresh-water drum			34,080	34,080
Cod	208,800,060	175,341,000		384,141,000
Haddock	188,940,000	271,880,000		466,820,000
Pollock		455,066,000		455,066,000
Winter flounder		1,768,660,000		1,768,660,000
Pole flounder	19,410,000			19,410,000
Miscellaneous fishes			4,935,165	4,935,165
Total	1,109,637,130	3,626,262,730	226,589,545	4,962,489,405

EGG COLLECTIONS.

The egg collections for the year were obtained from the usual sources without material change in methods of procedure or the entrance into new fields. A comparison of the work with the year previous indicates the usual fluctuations in the numbers of the vari-

ous species handled, caused primarily by local conditions of wind and weather. The total of the egg collections for the fiscal year 1922 exceeds that of the previous year by more than 431,000,000. It is evident that the annual egg collections represent practically the maximum production of the present fields of endeavor and that an increased volume of work, or an extension of the practical benefits of artificial propagation, can be accomplished only by the development of new fields. There are many points in various parts of the country affording excellent opportunities for such extension and promising most satisfactory results in practical returns to the fisheries. Any further extension of the work can be undertaken, however, only when additional funds are available.

Comparison of egg collections, fiscal years 1922 and 1921.

Species.	1922	1921	Species.	1922	1921
Buffalo fish	199,906,250	163,267,000	Lake trout	67,426,500	44,247,500
Carp	98,000,000	117,218,000	Brook trout	17,986,250	16,110,810
Shad	82,579,000	37,549,000	Smelt	300,000	8,000,000
Glut herring	116,920,000	55,130,000	Mackerel	2,022,000	.....
Whitefish	623,100,000	540,776,000	Pike perch	254,717,500	508,942,000
Cisco	429,900,000	317,200,000	Yellow perch	277,501,870	218,333,750
Chinook salmon	64,756,100	43,829,820	Striped bass	48,745,000	24,600,000
Chum salmon	22,830,000	28,182,000	Sea bass	32,000	.....
Humpbacked salmon	1,722,000	.....	Scup	3,425,000	.....
Silver salmon	13,618,500	8,273,000	Cod	587,426,000	482,012,000
Sockeye salmon	119,214,350	76,012,500	Haddock	543,110,000	635,950,000
Steelhead salmon	7,302,800	1,603,000	Pollock	507,270,000	650,850,000
Atlantic salmon	572,040	911,720	Winter flounder	2,312,029,000	1,980,291,000
Landlocked salmon	445,000	1,063,200	Pole flounder	5,090,000	19,410,000
Rainbow trout	11,210,500	10,994,750			
Black-spotted trout	9,220,300	5,993,600	Total	6,428,487,030	5,996,844,870
Loch Leven trout	109,870	94,220			

RESCUED FISHES.

The salvaging of stranded fishes from the overflowed lands along the Mississippi River has continued to be one of the most important and popular features of the bureau's work in fish conservation. During the fiscal year 1922 this work attained its greatest volume in the numbers of fish handled. A total of 179,475,069 fish were salvaged and either returned to original waters or delivered to applicants for planting in adjacent territory. The salvaged fishes comprise practically every useful species indigenous to the region. The table indicates by localities and by species the total numbers of fish salvaged, the numbers restored to original waters, and the numbers delivered to applicants. A full discussion of the more important details of the work occurs on page 57.

Number and disposition of fish rescued, fiscal year 1922.

Station and species.	Delivered to applicants.	Restored to original waters.	Total.
Bellevue, Iowa:			
Black bass	16,052	21,460	37,512
Buffalo fish	.....	357,000	357,000
Carp	300	6,929,700	6,930,000
Catfish	28,295	2,286,425	2,314,720
Crappie	7,755	4,326,730	4,334,485
Drum	60	.....	60
Pike and pickerel	.....	460	460

Number and disposition of fish rescued, fiscal year 1922—Continued.

Station and species.	Delivered to applicants.	Restored to original waters.	Total.
Bellevue, Iowa—Continued.			
Pike perch		340	340
Rock bass	1,180		1,180
Sunfish	41,480	13,147,900	13,189,380
White bass		725	725
Yellow perch	625	1,105	1,730
Miscellaneous		6,274,025	6,274,025
Total	95,747	33,345,870	33,441,617
Fairport, Iowa, and auxiliaries:			
Black bass		21,200	21,200
Buffalo fish		320,865	320,865
Carp		47,460	47,460
Catfish		223,935	223,935
Crappie		345,870	345,870
Sunfish		315,195	315,195
White bass		1,575	1,575
Miscellaneous		9,420	9,420
Total		1,285,520	1,285,520
Homer, Minn:			
Black bass	60,440	166,730	227,170
Buffalo fish		61,506	61,506
Carp	40	3,483,905	3,483,945
Catfish	17,720	8,946,375	8,964,095
Crappie	8,207	12,707,503	12,715,710
Drum		25,585	25,585
Pike and pickerel		598,673	598,673
Sunfish	61,260	11,549,725	11,610,985
White bass		14,460	14,460
Yellow perch	6,900	1,209,885	1,216,785
Miscellaneous		14,450	14,450
Total	154,567	38,778,797	38,933,364
La Crosse, Wis:			
Black bass	46,885	51,130	98,015
Buffalo fish	4,570	1,185,355	1,189,925
Carp	110	7,421,240	1,421,350
Catfish	23,230	26,492,970	26,516,200
Crappie	13,030	14,564,180	14,577,210
Drum		7,280	7,280
Pike and pickerel		62,930	62,930
Pike perch		34,050	34,050
Sunfish	46,040	19,539,510	19,585,550
White bass		13,300	13,300
Yellow perch	1,465	342,845	344,310
Miscellaneous		4,030,460	4,030,460
Total	135,330	73,745,250	73,880,580
Marquette, Iowa:			
Black bass	26,756	22,230	48,986
Buffalo fish		1,007,550	1,007,550
Carp		3,854,900	3,854,900
Catfish	24,680	13,610,200	13,634,880
Crappie	6,075	4,238,405	4,244,480
Drum		209,100	209,100
Pike and pickerel		17,730	17,730
Rock bass		2,800	2,800
Sunfish	7,341	6,736,179	6,743,520
White bass		6,250	6,250
Yellow perch	1,745	39,780	41,525
Miscellaneous		54,000	54,000
Total	66,597	29,799,124	29,865,721
Meredosia, Ill:			
Black bass	2,100	15,827	17,927
Buffalo fish		306,600	306,600
Carp	150	269,000	269,150
Catfish	11,500	425,450	436,950
Crappie	580	243,520	244,100
Sunfish	8,585	658,755	667,340
White bass		200	200
Miscellaneous		20,000	20,000
Total	22,915	1,939,352	1,962,267

Number and disposition of fish rescued, fiscal year 1922—Continued.

Station and species	Delivered to applicants.	Restored to original waters.	Total.
San Marcos, Tex:			
Black bass		11,500	11,500
Catfish		32,500	32,500
Sunfish		62,000	62,000
Total		106,000	106,000
Total of all stations:			
Black bass	152,233	310,077	462,310
Buffalo fish	4,570	3,238,876	3,243,446
Carp	600	22,006,205	22,006,805
Catfish	105,425	52,017,855	52,123,280
Crappie	35,647	36,426,208	36,461,855
Drum	60	241,965	242,025
Pike and pickerel		679,793	679,793
Pike perch		34,390	34,390
Rock bass	1,180	2,800	3,980
Sunfish	164,706	52,009,264	52,173,970
White bass		36,510	36,510
Yellow perch	10,735	1,593,615	1,604,350
Miscellaneous		10,402,355	10,402,355
Grand total	475,156	178,999,913	179,475,069

STATIONS AND SUBSTATIONS AND OUTPUT OF EACH.

The fish-cultural work was conducted from the 73 regularly established stations, no funds being available for new construction. The main stations, with their substations operative during the fiscal year 1922, are listed alphabetically in the accompanying table, which also indicates the period of operation of each and the numbers of fish and eggs produced at each point by artificial propagation, by transfers from field stations, and from rescue operations.

Stations and substations operated and output of each, fiscal year 1922.

[Asterisk (*) indicates that additional eggs were transferred to other stations. See table, p. 18. All stations and substations operated the entire year, except those where months are given.]

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Afognak, Alaska	Sockeye salmon		4,100,000	28,480,000	32,580,000
Baird, Calif.	Chinook salmon			1,500,000	1,500,000
Battle Creek, Calif.	do			2,386,000	2,386,000
Mill Creek, Calif.	do			1,986,200	1,986,200
Baker Lake, Wash.	Sockeye salmon		3,950,000	4,340,000	8,290,000
Birdsview, Wash.	Chinook salmon			521,720	521,720
	Humpbacked salmon			111,000	111,000
	Silver salmon			7,085,240	7,085,240
	Sockeye salmon			40,000	40,000
	Steelhead salmon	*55,000		78,000	133,000
Brinnon, Wash. (November–February).	Chum salmon		1,040,000		1,040,000
	Silver salmon			24,700	24,700
Duckabush, Wash.	Chum salmon		500,000	7,127,960	7,627,960
	Humpbacked salmon			783,800	783,800
	Silver salmon			309,000	309,000
	Steelhead salmon			90,300	90,300
Quilcene, Wash.	Chum salmon			6,899,650	6,899,650
	Silver salmon			450,000	450,000
	Steelhead salmon	*60,000		93,100	153,100
Quinault, Wash.	Chinook salmon			47,000	47,000
	Silver salmon		600,000	948,000	1,548,000
	Sockeye salmon		250,000	3,295,000	3,545,000

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Baker Lake, Wash.—Continued.					
Sultan, Wash.	Chinook salmon			147,300	147,300
	Humpbacked salmon			14,600	14,600
	Silver salmon			2,148,000	2,148,000
	Steelhead salmon			104,400	104,400
Berkshire, Mass.	Brook trout			217,420	217,420
	Pike perch		3,000,000		3,000,000
	Rainbow trout			41,677	41,677
	Yellow perch		200,000		200,000
Boothbay Harbor, Me.	Winter flounder		922,777,000		922,777,000
Bozeman, Mont.	Black-spotted trout			392,000	392,000
	Brook trout			454,175	454,175
	Rainbow trout			395,000	395,000
Glacier Park, Mont. (July and August; June).	Black-spotted trout			168,000	168,000
	Brook trout			48,000	48,000
	Rainbow trout			250,000	250,000
Meadow Creek, Mont. (April-June).	Black-spotted trout		425,000		425,000
	Rainbow trout	*540,000	30,000		570,000
Cape Vincent, N. Y.	Brook trout		410,500		410,500
	Cisco	*215,690,000	47,400,000		263,090,000
	Lake trout		743,200		743,200
	Rainbow trout		157,000		157,000
	Whitefish	*100,242,000	32,000,000		132,242,000
	Yellow perch		10,000,000		10,000,000
Central Station, Washington, D. C.	Brook trout			1,200	1,200
	Chinook salmon			6,000	6,000
	Large-mouthed black bass			45	45
	Rainbow trout			33,775	33,775
	Sunfish			190	190
	Yellow perch		2,000,000		2,000,000
Bryans Point, Md. (March-May).	Shad		35,802,200		35,802,200
	Yellow perch	(*)	171,102,700		171,102,700
Clackamas, Oreg.	Black-spotted trout			23,000	23,000
	Brook trout		50,000	120,000	170,000
	Chinook salmon	(*)	100,000	8,957,300	9,057,300
	Grayling		250,000		250,000
	Rainbow trout			69,965	69,965
Applegate, Oreg.	Silver salmon			110,000	110,000
	Steelhead salmon	*150,000		1,552,700	1,702,700
Big White Salmon, Wash.	Chinook Salmon			14,834,000	14,834,000
Little White Salmon, Wash.	Chinook salmon	1,400,000		24,582,000	25,982,000
	Sockeye salmon			26,365	26,365
Rogue River, Oreg.	Chinook salmon		1,211,550	344,350	1,555,900
	Steelhead salmon			109,720	109,720
Salmon, Idaho (July-September).	Chinook salmon			224,000	224,000
Sandy River, Oreg. (August-September; April-July).	Chinook salmon			123,000	123,000
Upper Clackamas, Oreg.	Chinook salmon			2,111,000	2,111,000
Washougal, Wash. (April-June).	Steelhead salmon	185,000			185,000
Cold Springs, Ga.	Catfish			8,200	8,200
	Crappie			325	325
	Large-mouthed black bass		45,000	84,985	129,985
	Sunfish			87,000	87,000
Craig Brook, Me.	Atlantic salmon	(*)	1,334,000	180	1,334,180
	Brook trout		491,000	57,600	548,600
	Humpbacked salmon		369,860		369,860
	Landlocked salmon		64,000		64,000
	Rainbow trout		24,000		24,000
Duluth, Minn.	Brook trout		110,000		110,000
	Lake trout	*1,550,000	11,724,000	151,000	13,326,000
	Pike perch		150,000		150,000
	Rainbow trout		31,200	58,800	90,000
	Whitefish		15,950,000		15,950,000
Edenton, N. C.	Glut herring		82,600,000		82,600,000
	Large-mouthed black bass			38,509	38,509
	Shad		27,659,000		27,659,000
	Sunfish			12,175	12,175
Weldon, N. C. (April-May).	Striped bass		25,530,000		25,530,000
Erwin, Tenn.	Brook trout		57,000	159,000	216,000
	Large-mouthed black bass		2,000	19,620	21,620

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Erwin, Tenn.—Con.	Rainbow trout	*100,000		669,000	769,000
	Rock bass			13,850	13,850
	Small-mouthed black bass			6,305	6,305
	Sunfish			20,706	20,706
Fairport, Iowa, and four substations.	Buffalo fish			418,905	418,905
	Carp			47,460	47,460
	Catfish			223,935	223,935
	Crappie			345,870	345,870
	Large-mouthed black bass			21,200	21,200
	Sunfish			425,375	425,375
	Warmouth bass			1,860	1,860
	White bass			1,575	1,575
	Miscellaneous			9,420	9,420
Gloucester, Mass.	Cod	124,060,000	145,750,000		269,810,000
	Winter flounder		100,220,000		100,220,000
	Haddock	75,960,000	290,820,000		366,780,000
	Pole flounder	5,090,000			5,090,000
	Pollock		327,380,000		327,380,000
Green Lake, Me.	Brook trout		129,600		129,600
	Landlocked salmon	*15,000	122,230		137,230
	Small-mouthed black bass		22,000		22,000
	Smelt		300,000		300,000
Grand Lake Stream, Me.	Brook trout	5,000	101,830		106,830
	Landlocked salmon	100,000	21,000	67,860	188,860
Homer, Minn.	Buffalo fish	57,056,000		61,506	57,117,506
	Carp			3,483,945	3,483,945
	Catfish			8,964,095	8,964,095
	Crappie			12,715,710	12,715,710
	Fresh-water drum			25,585	25,585
	Large-mouthed black bass			227,170	227,170
	Pike and pickerel			598,673	598,673
	Rock bass			4,100	4,100
	Sunfish			11,610,985	11,610,985
	White bass			14,460	14,460
	Yellow perch			1,216,785	1,216,785
	Miscellaneous			14,450	14,450
Atchafalaya, La. (March-April).	Buffalo fish	29,850,000	51,000,000		80,850,000
Bellevue, Iowa (July-November)	Buffalo fish			357,000	357,000
	Carp			6,930,000	6,930,000
	Catfish			2,314,720	2,314,720
	Crappie			4,334,485	4,334,485
	Fresh-water drum			60	60
	Large-mouthed black bass			37,512	37,512
	Pike and pickerel			460	460
	Pike perch			340	340
	Rock bass			1,180	1,180
	Sunfish			13,189,380	13,189,380
	White bass			725	725
	Yellow perch			1,730	1,730
	Miscellaneous			6,274,025	6,274,025
La Crosse, Wis.	Brook trout			465,400	465,400
	Buffalo fish			1,189,925	1,189,925
	Carp			7,421,350	7,421,350
	Catfish			26,516,200	26,516,200
	Crappie			14,577,210	14,577,210
	Fresh-water drum			7,280	7,280
	Large-mouthed black bass			98,015	98,015
	Pike and pickerel			62,930	62,930
	Pike perch		450,000	34,050	484,050
	Rainbow trout			33,000	33,000
	Sunfish			19,585,550	19,585,550
	White bass			13,300	13,300
	Yellow perch			344,310	344,310
	Miscellaneous			4,030,460	4,030,460
Marquette, Iowa (July-November)	Buffalo fish			1,007,550	1,007,550
	Carp			3,854,900	3,854,900
	Catfish			13,634,880	13,634,880
	Crappie			4,244,480	4,244,480
	Fresh-water drum			209,100	209,100
	Large-mouthed black bass			48,986	48,986
	Pike and pickerel			17,730	17,730
	Rock bass			2,800	2,800
	Sunfish			6,743,520	6,743,520
	White bass			6,250	6,250
	Yellow perch			41,525	41,525
	Miscellaneous			54,000	54,000
Meredosia, Ill. (July-September)	Buffalo fish			306,600	306,600
	Carp			269,150	269,150
	Catfish			436,950	436,950

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Homer, Minn.—Con.					
Meredosia, Ill. (July–September)—Continued.	Crappie			244,100	244,100
	Large-mouthed black bass			17,927	17,927
	Sunfish			667,340	667,340
	White bass			200	200
	Miscellaneous			20,000	20,000
Leadville, Colo	Black-spotted trout			348,000	348,000
	Brook trout	(*)	485,000	2,786,000	3,271,000
	Lake trout			25,000	25,000
	Loch Leven trout			20,000	20,000
	Rainbow trout			99,100	99,100
Yellowstone Park, Wyo. (July–September).	Black-spotted trout	*1,097,500	68,000		1,165,500
	Rainbow trout		80,000		80,000
Louisville, Ky	Large-mouthed black bass			1,225	1,225
	Rock bass			1,800	1,800
	Small-mouthed black bass.		345,000	1,500	346,500
	Sunfish			64,740	64,740
	Yellow perch		225,000	310	225,310
Mammoth Spring, Ark.	Large-mouthed black bass.		14,000	24,520	38,520
	Rock bass			3,450	3,450
	Small-mouthed black bass.		63,000	2,600	65,600
	Sunfish			13,200	13,200
Manchester, Iowa	Brook trout			597,150	597,150
	Pike perch		60,000		60,000
	Rainbow trout	*126,600		159,590	286,190
	Rock bass		800	8,600	9,400
	Small-mouthed black bass.			480	480
Nashua, N. H	Brook trout			475,550	475,550
	Lake trout			16,100	16,100
	Landlocked salmon			20,000	20,000
	Pike perch		1,250,000		1,250,000
	Rainbow trout			26,880	26,880
	Small-mouthed black bass.		19,500		19,500
	Yellow perch		200,000		200,000
Neosho, Mo	Crappie			4,290	4,290
	Large-mouthed black bass.			52,569	52,569
	Rainbow trout	244,000		433,847	677,847
	Rock bass			1,973	1,973
	Small-mouthed black bass.			223	223
	Sunfish			58,485	58,585
	Yellow perch	4,000,000	900,000		4,900,000
Northville, Mich	Brook trout		40,000		40,000
	Rainbow trout		88,000	1,800	89,800
	Small-mouthed black bass.		82,750	64,125	146,875
Alpena, Mich. (November–December; March–April).	Lake trout		1,204,000		1,204,000
	Whitefish		3,800,000		3,800,000
Bay City, Mich. Apr. 1–28).	Pike perch	75,450,000			75,450,000
Charlevoix, Mich	Brook trout		10,000		10,000
	Lake trout	*1,246,000	15,520,000		16,766,000
	Whitefish	160,000	50,000,000		50,160,000
Orangeburg, S. C	Catfish			440	440
	Crappie			395	395
	Large-mouthed black bass.		131,700	126,086	257,786
	Sunfish			13,735	13,735
	Warmouth bass			655	655
Put in Bay, Ohio	Carp		82,050,000		82,050,000
	Cisco	5,000,000			5,000,000
	Pike perch	*4,200,000	46,000,000		50,200,000
	Whitefish	*55,840,000	204,600,000		260,440,000
	Yellow perch	*30,000,000	16,000,000		46,000,000
St. Johnsbury, Vt	Brook trout		932,120		932,120
	Lake trout		45,900		45,900
	Small-mouthed black bass.			1,950	1,950
Holden, Vt	Brook trout		312,000	58,750	370,750
	Lake trout		122,265	20,990	143,255
	Landlocked salmon			7,925	7,925

Stations and substations operated and output of each, fiscal year 1922—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
St. Johnsbury, Vt.—Continued.					
Holden, Vt.—Con.	Rainbow trout			11,900	11,900
Swanton, Vt. (March-May).	Pike perch	(*)	4,987,000		4,987,000
	Yellow perch	*400,000	6,900,000		7,300,000
San Marcos, Tex	Catfish			37,500	37,500
	Crappie			620	620
	Large-mouthed black bass.			883,545	883,545
	Rock bass			845	845
	Sunfish			86,035	86,035
Saratoga, Wyo	Brook trout			398,500	398,500
	Loch Leven trout			9,000	9,000
	Rainbow trout	*446,240		478,500	924,740
Spearfish, S. Dak	Brook trout			301,500	301,500
	Loch Leven trout			27,000	27,000
	Rainbow trout			181,500	181,500
Springville, Utah	Brook trout	*250,000		95,260	345,260
	Catfish			960	960
	Rainbow trout	276,000		548,500	824,500
Tupelo, Miss	Crappie			1,075	1,075
	Large-mouthed black bass.		23,500	273,210	296,710
	Sunfish			86,600	86,600
White Sulphur Springs, W. Va.	Brook trout			618,950	618,950
	Large-mouthed black bass.		64,500	1,400	65,900
	Rainbow trout	*560,000		716,600	1,276,600
	Rock bass			5,160	5,160
	Small-mouthed black bass.		36,000	375	36,375
	Sunfish			16,600	16,600
Woods Hole, Mass	Cod	*84,164,000	86,381,000		170,545,000
	Winter flounder	193,178,000	844,381,000		1,037,559,000
	Steelhead salmon		20,000		20,000
	Miscellaneous		4,517,000		4,517,000
ytheville, Va	Brook trout			53,000	53,000
	Large-mouthed black bass.		1,000	6,685	7,685
	Rainbow trout	*85,000		307,850	392,850
	Rock bass			8,600	8,600
	Sunfish			16,900	16,900
Yes Bay, Alaska	Humpbacked salmon			210,000	210,000
	Sockeye salmon	150,000	24,300,000	23,340,000	47,790,000
Gross output		1,068,981,340	3,716,707,605	339,576,253	5,125,265,198
Loss in transit			20,000	143,878	163,878
Net output		1,068,981,340	3,716,687,605	339,432,375	5,125,101,320

EGG-COLLECTING OR AUXILIARY STATIONS.

In addition to the stations and substations listed in the foregoing table there are operated each year a varying number of field or auxiliary stations from which egg collections are made. These are temporary stations occupied only during the spawning season, or mere camps that are shifted from time to time as the exigencies of the work may make advisable. The eggs obtained at these field stations are either transferred to the main hatcheries for incubation immediately in the green stage, or, where the distance involved is too great to permit of making the transfer of green eggs, they are retained at the collecting station until reaching the eyed stage before transfer takes place. At points on the Great Lakes and off the New England coast egg collections are made by the bureau's boats in favorable localities. The following stations were operative for egg collections during 1922. The period of occupation and the species of fish eggs produced are noted in each case.

Egg-collecting stations, period of operation, and species handled, fiscal year 1922.

Station.	Period of operation.	Species handled.
Boothbay Harbor, Me.:		
Cundys Harbor, Me	March	Winter flounder.
Linekins Bay, Me	March and April	Do.
Pemaquid, Me	March	Do.
Phippsburg, Me	March and April	Do.
Rockland, Me	do	Do.
Southport, Me	do	Do.
Thomaston, Me	do	Do.
Cape Vincent, N. Y.:		
Bygotts Point, Ontario	November	Cisco, whitefish.
Chaumont Bay, N. Y	do	Do.
Deseronto, Ontario	do	Do.
Fairhaven Bay, N. Y	do	Cisco.
Grass Bay, N. Y	April	Yellow perch.
Henderson Bay, N. Y	November	Cisco.
Pigeon Island, Ontario	October and November	Lake trout.
Stony Island, N. Y	do	Do.
Sodus Bay, N. Y	November	Whitefish.
South Bay, Ontario	do	Cisco.
Clackamas, Oreg.:		
Lemhi, Idaho	June to September	Chinook salmon.
Pahsimeroi, Idaho	do	Do.
Duluth, Minn.:		
Au Train, Mich	October	Lake trout.
Betsie River, Mich	do	Do.
Fishermans Home, Mich	September to November	Lake trout, whitefish.
Fish Island, Mich	do	Do.
Gay, Mich	October	Lake trout.
Grand Marais, Mich	do	Do.
Isle Royale, Mich	do	Do.
Keystone, Mich	do	Do.
Long Point, Mich	September to November	Lake trout, whitefish.
Manitou Island, Mich	October	Lake trout.
Marquette, Mich	October to November	Do.
Munising, Mich	do	Do.
Portage Entry, Mich	do	Do.
Portage Lake Canal, Mich	October	Do.
Rock Harbor, Mich	September to November	Lake trout, whitefish.
Siscowit Bay, Mich	do	Do.
Tobens Harbor, Mich	do	Do.
Todds Harbor, Mich	do	Do.
Washington Harbor, Mich	do	Do.
Leadville, Colo.:		
Carroll Lake, Colo	October and November	Brook trout, Loch Leven trout.
Englebrecht Lake, Colo	September to November	Brook trout.
Evergreen Lakes, Colo	October and November	Do.
Fred Neal Lake, Colo	do	Do.
Musgroves Lake, Colo	do	Do.
Northfield Lake, Colo	do	Do.
Turquoise Lake, Colo	do	Do.
Yellowstone Park, Wyo	July to September and June	Black-spotted trout.
Chipmunk Creek	July	Do.
Clear Creek	do	Do.
Columbine Creek	do	Do.
Cub Creek	do	Do.
Flat Mount Arm	do	Do.
Grouse Creek	do	Do.
Pelican Creek	do	Do.
Soda Butte	June	Do.
Thumb Creek	July	Do.
Nashua, N. H.: Lake Sunapee, N. H	June	Small-mouthed black bass.
Neosho, Mo.: Roaring River, Mo	November to February	Rainbow trout.
Northville, Mich:		
Fairport, Mich	November	Lake trout.
Frankfort, Mich	do	Do.
Gould City, Mich	do	Whitefish.
Manistique, Mich	do	Lake trout.
Naubinway, Mich	do	Whitefish.
Northport, Mich	do	Lake trout.
St. James, Mich	do	Do.
St. Joseph, Mich	do	Do.
Put in Bay, Ohio:		
Catawba Island, Ohio	November and December	Whitefish.
Middle Bass Island, Ohio	do	Do.
	April and May	Yellow perch.
North Bass Island, Ohio	November and December	Whitefish.
	April	Pike perch.
Port Clinton, Ohio	November	Whitefish.
	April to June	Pike perch, yellow perch, carp.
Toledo, Ohio	November	Whitefish.
	April	Pike perch.

Egg-collecting stations, period of operation, and species handled, etc.—Continued.

Station.	Period of operation.	Species handled.
St. Johnsbury, Vt.:		
Darling Pond, Vt	October and November	Brook trout.
Lake Mitchell, Vt	do	Do.
Margalloway River, Me	September and October	Do.
Parmacheence Lake, Me	October	Do.
York Pond, N. H	Entire year	Do.
Saratoga, Wyo.:		
Canon Creek, Wyo	April to June	Rainbow trout.
Lost Creek, Wyo	do	Do.
Sage Creek, Wyo	do	Do.
Springville, Utah: Fish Lake, Utah	November	Brook trout.
Woods Hole, Mass:		
Newport, R. I	March and April	Winter flounder.
Waquoit, Mass	January to March	Do.
Wickford, R. I	March	Do.

TRANSFERS OF EGGS BETWEEN STATIONS.

Every year fish eggs in considerable numbers are transferred from one station to another. The primary object of such transfers is usually to give advantageous distribution centers for the resulting fry or fingerlings, as the eggs can be more economically and readily transported. Such transfers may also tend to reduce operating costs, and sometimes they represent an egg collection in excess of the hatching facilities at the collecting point. The transfers of eggs made during the fiscal year 1922 are indicated in the following table:

Transfers of eggs between stations, fiscal year 1922.[1]

Species.	Number of eggs.	From—	To—	Final disposition of fry or fingerlings.
Atlantic salmon	20,000	Craig Brook, Me	Central station, Washington, D. C.	Lost from chlorinated water.
Black-spotted trout.	200,000	Yellowstone Park, Wyo.	Bozeman, Mont	Montana waters.
	50,000	do	Clackamas, Oreg	Washington and Oregon waters.
	100,000	do	Glacier Park	Glacier Park streams.
	200,000	do	Leadville, Colo	Colorado waters.
Brook trout	500,000	Leadville, Colo	Bozeman, Mont	Colorado and Montana waters.
	300,000	Springville, Utah	do	Do.
	400,000	do	Cape Vincent, N. Y.	New York waters.
	400,000	do	Clackamas, Oreg	Washington and Oregon waters.
	400,000	do	La Crosse, Wis	Wisconsin waters.
	300,000	do	Spearfish, S. Dak	South Dakota waters.
	150,000	do	White Sulphur Springs, W. Va.	West Virginia waters.
Chinook salmon.[2]	20,000	Clackamas, Oreg	Central station, Washington, D. C.	Susquehanna River.
Cisco	1,500,000	Cape Vincent, N.Y.	do	Fry killed by chlorinated water.
Cod	30,070,000	Woods Hole, Mass.	Gloucester, Mass	Massachusetts Bay.
Lake trout	50,000	Duluth, Minn	Leadville, Colo	Capitol Lake, Franklin County, Colo.
	25,000	Charlevoix, Mich	Holden, Vt	Vermont waters.
Landlocked salmon.	70,000	Green Lake, Me	Craig Brook, Me	Maine waters.
	25,000	do	Nashua, N. H	New Hampshire waters.
Pike perch	4,000,000	Put in Bay, Ohio	La Crosse, Wis	Wisconsin waters.
	75,000	do	Manchester, Iowa	Iowa waters.
	3,000,000	Swanton, Vt	Hartsville, Mass	Root Pond, Big Pond, Knights Pond, Rooths Pond.
	1,600,000	do	Nashua, N. H	New Hampshire waters.
Rainbow trout.	500,000	Meadow Creek, Mont.	Clackamas, Oreg	Oregon and Washington waters.
	100,000	do	Duluth, Minn	Minnesota waters.
	20,000	Erwin, Tenn	Central station, Washington, D. C.	West Branch, Patuxent River.

[1] Where the distribution of the fish resulting involves a species not common or nonindigenous to the region the name of the water in which the plants were made is given. In most cases where the species involved are common to the locality in which the distribution is made these details are omitted.

[2] For exhibit.

Transfers of eggs between stations, fiscal year 1922 —Continued.

Species.	Number of eggs.	From—	To—	Final disposition of fry or fingerlings.
Rainbow trout —Continued.	80,000	Manchester, Iowa.	La Crosse, Wis.....	Wisconsin waters.
	100,000	Sage Creek, Wyo..	Leadville, Colo.....	Colorado waters.
	50,000	.....do.....	Salmon, Idaho.....	Idaho waters.
	50,000	.....do.....	Spearfish, S. Dak...	South Dakota waters.
	150,000	White Sulphur Springs, W. Va.	Cape Vincent, N. Y..	New York waters.
	50,000	.....do.....	Craig Brook, Me.....	Maine waters.
	50,000	.....do.....	Hartsville, Mass.....	Massachusetts waters.
	50,000	.....do.....	Holden, Vt.....	Vermont waters.
	55,000	Wytheville, Va...	Central station, Washington, D. C.	Lost from chlorinated waters.
	50,000	.....do.....	Nashua, N. H.....	New Hampshire waters.
Steelhead salmon.	25,000	Birdsview, Wash..	Manchester, Iowa...	Reserved for brood stock.
	25,000	.....do.....	Woods Hole, Mass..	Johns Pond, Mashpee, Mass.
	20,000	Quilcene, Wash...	Charlevoix, Mich....	Pine Lake, Charlevoix, Mich.
	50,000	Applegate Creek...	Bozeman, Mont.....	Montana waters.
Whitefish.....	1,600,000	Cape Vincent, N.Y.	Central station, Washington, D. C.	Fry lost from chlorinated water.
	24,950,000	.....do.....	Charlevoix, Mich....	Lake Michigan.
	25,400,000	Put in Bay, Ohio.	.....do.....	Do.
	25,500,000	.....do.....	Duluth, Minn.....	Lake Superior.
Yellow perch...	1,800,000	.....do.....	Central station, Washington, D. C.	Lost in transit.
	200,000	Swanton, Vt.....	Hartsville, Mass.....	Western Massachusetts waters.
	400,000	.....do.....	Nashua, N. H.....	New Hampshire waters.
	1,000,000	Bryans Point, Md.	Neosho, Mo.....	Missouri waters.
	200,000	.....do.....	Louisville, Ky.....	Ohio River–Louisville, Ky.
	500,000	.....do.....	Wytheville, Va.....	Lost in transit.

FISH FOOD USED AT HATCHERIES.

Since everyone undertaking a venture in the artificial propagation of fish must of necessity become interested in the problem of a suitable fish food, the following table, indicating the amounts and kinds of food used at the fish-cultural stations of the bureau during 1922, with the cost per pound, may be of interest.

Pounds and cost per pound of fish food used during fiscal year 1922.

PACIFIC SALMON STATIONS.

Station.	Salted salmon.		Canned salmon.		Frozen salmon eggs.		Beef liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Afognak, Alaska	200	$0.01						
Yes Bay, Alaska	3,000	.03						
Baker Lake and substations, Wash..	4,845	.02	8,880	$0.03			873	$0.10
Baird and substations, Calif.	7,000	.012					274	.09
Clackamas and substations, Oreg.	31,600	.013			21,335	$0.06		
Total	46,645		[1]8,880		21,335		1,147	

Station.	Beef spleen.		Pork liver.		Middlings.		Sheep liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Baker Lake and substations, Wash..	5,520	$0.05	1,520	$0.05			462	$0.05
Baird and substations, Calif.					400	$0.024		
Clackamas and substations, Oreg.	7,387	.036			3,182	.02		
Total	12,907		1,520		3,582		462	

[1] 6,000 pounds furnished by Washington State fisheries department, the cost being only the cost of packing the food from Concrete to Baker Lake.

Pounds and cost per pound of fish food used during fiscal year 1922—Con.

ROCKY MOUNTAIN TROUT STATIONS.

Station.	Beef liver.		Beef hearts.		Sheep liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Bozeman and substations, Mont.	7,492	$0.08				
Leadville, Colo.	20	.12				
Saratoga, Wyo.	1,083	.08	873	$0.065	1,946	$0.04
Spearfish, S. Dak.	200	.125	629	.115	3,709	.07
Springville, Utah.			9,374	.06	7,010	.05
Total.	8,795		10,876		12,665	

Station.	Pork liver.		Fishotine.		Middlings.		Fresh beef.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Bozeman and substations, Mont.	1,420	$0.065	49	$0.08				
Leadville, Colo.							850	$0.045
Spearfish, S. Dak.					2,500	$0.01		
Springville, Utah.					5,700	.025		
Total.	1,420		49		8,200		850	

NEW ENGLAND TROUT AND SALMON STATIONS.

Station.	Beef liver.		Beef hearts.		Beef spleen.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Berkshire trout hatchery, Mass.	992	$0.11			4,356	$0.05
Craig Brook, Me.	50	.09				
Green Lake, Me.			308	$0.05		
Nashua, N. H.	636	.09	239	.05		
St. Johnsbury and substations, Vt.	713	.11	1,351	.06		
Total.	2,391		1,898		4,356	

Station.	Sheep liver.		Pork liver.		Sheep plucks.		Fishotine.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Berkshire trout hatchery, Mass.	350	$0.05						
Craig Brook, Me.			317	$0.04				
Green Lake, Me.	256	.04			38	$0.03		
Nashua, N. H.	4,014	.05						
St. Johnsbury and substations, Vt.							120	$0.09
Total.	4,620		317		38		120	

STATIONS PROPAGATING BOTH TROUTS AND POND FISHES.

Station.	Beef liver.		Beef heart.		Sheep liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Erwin, Tenn.			4,787	$0.05	10,233	$0.05
Manchester, Iowa	21	$0.12	3,818	.05	14,007	.04
Neosho, Mo.			3,055	.04	6,779	.03
White Sulphur Springs, W. Va.	430	.06	15,029	.05	17,694	.04
Wytheville, Va.			3,530	.05	7,110	.06
Total.	451		30,219		55,823	

Station.	Azotine.		Middlings.		Pork hearts.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Erwin, Tenn.			4,250	$0.04		
Manchester, Iowa			860	.02		
Neosho, Mo.			3,400	.02	2,794	$0.03
Wytheville, Va.	150	$0.07	5,782	.02		
Total.	150		14,292		2,794	

Pounds and cost per pound of fish food used during fiscal year 1922—Con.

POND FISH-CULTURAL STATIONS.

Station.[2]	Beef liver.		Beef heart.		Fresh fish.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Cold Springs, Ga., and substations	.....	.....	5,813	$0.07	530	$0.10
Edenton, N. C.	.....	.....	.....	.....	259	.125
Louisville, Ky.	42	$0.10	395	.11	.....	.....
Mammoth Spring, Ark.	230	.15	513	.12	.....	.....
Orangeburg, S. C.	.....	.....	1,136	.10	.....	.....
Tupelo, Miss.	.....	.....	1,700	.08	.....	.....
Total	272	.....	9,557	.....	789	.....

Station.[2]	Fishotine.		Shorts.		Bone meal.		Pork liver.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Cold Springs, Ga., and substations	800	$0.07	500	$0.02	75	$0.07	.....	.....
Louisville, Ky.	.....	.....	.....	.....	.....	.....	5	$0.10
Total	800	.....	500	.....	75	.....	5	.....

[2] No artificial foods used at the San Marcos (Tex.) station.

HATCHERY FISH-CULTURAL NOTES.

NEW METHOD OF PRESENTING FOOD TO TROUT FRY AND FINGERLINGS.

Of interest in connection with the subject of suitable foods for fish is the proper manner of supplying it. During 1922 a new method, recommended by an employee of the New York Aquarium, was tried at a number of the stations. It consists in placing the prepared food in shallow vessels, clamshells were suggested, at convenient intervals on the bottom of the trough or pond in which the young fish were being held. Several of the bureau's superintendents, under whose direction the test was made, were favorably impressed by the change, while with others it found little favor. Some of the comments on it are noted below:

Wytheville (Va.) Station.—The dishes were filled twice a day with finely chopped beef heart, and the fish seemed to feed continuously, a group being constantly over the containers. These fish made no better growth than did those fed by the usual methods, the mortality was not lessened, and much food was wasted.

Manchester (Iowa) Station.—The idea possesses much merit, especially in the feeding of sheep liver. The young fish learn to partake of the food readily, and very little is wasted. The idea has not proved an advantage in the feeding of beef heart.

White Sulphur Springs (W. Va.) Station.—The fish fed in the regular manner appeared to be more uniform in size, and there was no perceptible difference as to the cleanliness of the troughs.

In preparing food for fry and fingerling trout a number of the superintendents are finding the use of a common eggbeater of practical value. The meat is prepared in the usual manner and placed in a deep pan, with sufficient water to bring it to the proper consistency. It is then thoroughly mixed with an eggbeater. This removes practically all the small particles of connective tissue and muscle which ordinarily pass through the finest plate of the food chopper and are frequently troublesome in clogging the screens and fouling the troughs.

EGG MEASUREMENTS.

For practical fish-cultural purposes the desirability of adopting a standard of measurement for the eggs of such fishes as the whitefish, cisco, yellow perch, pike perch, the marine species, and others that produce eggs of small size in large numbers has long been apparent. Because of these variations in size the standard would be to some extent arbitrary, but if recognized by all fish-culturalists its practical value in keeping uniform records of eggs collected and distributed is evident.

In making shipment of such eggs from point to point it not infrequently happens that the eggs are measured by the consignor under one standard, while the consignee uses another. A recognized standard of measure would obviate this confusion. In view of the rather rapid change in the size of the eggs of most fishes after fertilization and during incubation, it is desirable to have one standard measure for eggs in the green stage and another for eyed eggs.

HATCHING EGGS IN GRAVEL.

Recently many fish-culturists have become interested in the so-called gravel method of incubating the eggs of salmon and trout. This method, originated, we believe, by Alexander Robertson, a Canadian fish-culturist, consists in placing the fertilized eggs, either green or eyed, in a suitable receptacle between alternate layers of gravel, all of the eggs being completely covered. The receptacle is then so placed as to receive a constant flow of water by seepage through the gravel, the volume not being sufficient to disturb the eggs.

Experiments conducted along this line at a number of the bureau's stations with eggs of the sockeye and chinook salmons and rainbow and brook trouts have yielded fairly uniform results. The experiments have involved placing the eggs in gravel in various kinds of containers, in hatching troughs, in rearing ponds in the open air, and in the beds of creeks. In practically every instance a good percentage of hatch has been obtained, except in cases where the water circulation was imperfect or where frost had penetrated to the eggs. The former point is illustrated by the following report from the superintendent of the St. Johnsbury (Vt.) station:

> Last winter, 1921, we put 4,000 brook-trout eggs in a box about 1 foot square under the west end of the York Pond Dam. The box was set in such a way that the water was forced up through eggs and gravel. There was a considerable loss of eggs in the corners of the box, but otherwise they hatched normally. My judgment is that the loss was due to imperfect circulation in the box.

Observers of the experiments are also very nearly unanimous in the opinion that the fry produced by this means of incubation are exceptionally virile, are darker in color than fry hatched by the usual methods, and do not emerge from the gravel until the near approach of the feeding stage.

It seems hardly probable that the method can be developed to a point where it will be of direct value in hatchery operations or that it will replace present methods of incubating the eggs of salmon and trout, particularly where such eggs are to be handled in

large numbers. It is of much interest, however, in connection with the suggested possibilities as to its value in stocking lakes and streams with eyed eggs rather than the more expensive fry or fingerlings.

The available information on the subject indicates that practically perfect results, in so far as incubation is concerned, may be expected from eyed eggs of the trouts or salmons when planted in the deep gravel bed of a suitable stream where a substream flow or spring seepage is present, and one of these conditions doubtless always obtains in a stream flowing gently over a bed of deep gravel. Trout or salmon spawning naturally in streams invariably seek such places, and trout spawning in ponds will seek seeping water, either in the nature of spring seepage entering the pond or water seeping from the pond through a porous section of its bottom. Observations made during the summer of 1921 of a number of plants of eyed eggs of the black-spotted trout in the Belcher River and tributaries, in the Yellowstone National Park, under the conditions named above, revealed a 100 per cent hatch in each instance, and the resulting fry were uniformly strong and vigorous. They displayed all the tendencies of naturally hatched fish, burying themselves in the gravel to a depth of 8 or more inches and remaining there during the time required for the absorption of the umbilical sac. The evidence at hand would indicate that eggs planted in a dead pond bottom result in total failure. If this method of stocking streams and lakes can be carried out as successfully as now seems possible, it will offer in innumerable instances many advantages over present methods. It will permit of making plants at the headwaters of streams or of the tributaries of lakes, always a desirable location, though inaccessible with fry or fingerlings, and of making distributions over a greater water area. It will also materially reduce the costs of distribution and hatchery expenses.

METHODS OF PLANTING EYED EGGS.

In making plants of eggs in the bed of a stream it is impossible, because of their buoyant tendency and the action of the current, simply to scoop out a "nest," deposit the eggs therein, and cover them with gravel. Several ways have been resorted to in making such plants. A method employed on the Pacific coast is to place the eggs to be planted in alternate layers with gravel in a box or can—a 5-gallon coal-oil can is mentioned. An excavation of sufficient size and depth is made in the gravel bed at the site selected and the can is carefully inverted into it, allowing its contents to settle into the excavation. In other places two pieces of board or plank are fastened together to form a V. This is placed in the stream with its apex against the current. The "nest" is then made in the eddy or slack water in the angle of the V.

ACCLIMATIZATION.

Throughout the history of practical fish culture numerous instances are to be noted of the successful establishment of nonindigenous fishes in various parts of this country and also in many of the foreign countries. In most cases such transplantings have resulted in

direct benefit, though in others the good effects have been less obvious. Among the more recent occurrences of this character may be mentioned the successful introduction into certain Maine rivers of the humpbacked salmon of the Pacific coast, which is referred to on page 57 of this report. The introduction of the smelt in the Great Lakes is also of interest. The bureau claims no credit and no responsibility in connection with the latter, but it is referred to as an item of interest to fish-culturists. The records show that eggs of the smelt were furnished the State of Michigan from the Green Lake (Me.) station during the fiscal years 1909, 1912, 1914, 1915, 1916, and 1921. Information reached the bureau in the spring of 1922 that the species had been noted in considerable numbers in Crystal Lake, Mich., and also in points in Lake Michigan, notably in Grand Traverse Bay.

There seems to be considerable difference of opinion as to the effect the smelt may have on the indigenous fishes. A number of persons appear to hail the advent of the smelt in the Great Lakes as a cause of rejoicing, although others are inclined to view the matter with gloomy forebodings. Aside from their value as food for humans, which is considerable, the smelt is recognized in many bodies of water as a valuable asset in the way of food for the game fish. In fact, it seems to be fairly well demonstrated that certain species of game fish, notably the landlocked salmon, do not attain to their highest quality when introduced in waters where the smelt does not occur. The final results of the establishment of smelt in the Great Lakes are, however, problematical and will be watched with interest.

COMMERCIAL FISHES.

Of the 73 stations and substations operated during the fiscal year 1922, the work of 42, including the rescue stations, was addressed to the propagation or conservation of fishes commercially important. This group of stations produced approximately 99 per cent of the entire output. The results of the season's work may be considered fairly successful. The output was increased over that of the preceding fiscal year, and the work was accomplished at a smaller outlay of funds. However, this continued reduction of funds available for fish culture is having an unfavorable effect, and it is preventing the fullest development of many valuable fields. A discussion of the more important details of the work of the stations handling the commercial fishes during the past year follows.

PACIFIC SALMONS.

In the artificial propagation of fish perhaps no branch of the work ranks higher in importance than that addressed to the salmons of the Pacific coast. While it is difficult to check the actual returns from the culture of the commercial fishes, which are distributed over wide areas in the open waters, or to say positively that an increase in the number of fish in a given locality is the result of hatchery work uninfluenced by other considerations, the evidence at hand indicates that the Pacific coast salmon hatcheries are in most instances entitled to high ranking from the standpoint of practical returns on the effort expended. Salmon hatching during the fiscal year 1922 was conducted at 20 stations, located in the States of Washington, Idaho,

Oregon, and California, and in the Territory of Alaska. The aggregate output of these stations for the year amounted to 183,992,815 eggs, fry, and fingerlings of the salmon, as against a total of 146,107,040 the preceding year. Of the 1922 output 145,542,405 were fingerling fish, while the fingerlings produced in 1921 numbered 92,066,730.

AFOGNAK (ALASKA) STATION.

[EDWIN WENTWORTH, Superintendent.]

For the fifth consecutive season since the destruction of the spawning beds by the volcanic deposit in 1912 there was an excellent run of sockeye salmon in Letnik Lake and no trouble was experienced in obtaining the desired number of eggs, notwithstanding the escape of large numbers of fish over the racks during a period of high water in early August. It is estimated that the season's egg collection, which amounted to 53,835,000, was secured from approximately one-fourth of the salmon entering the lake. The work of incubation was hampered by a scarcity of water, as a result of dry weather extending through August and well into September. By constant and assiduous attention, however, the stock was carried through without abnormal loss, though the high temperatures prevailing during the drought caused the eggs to hatch fully three weeks earlier than under normal conditions. The stacked trays were again used in holding the fry through the period of absorbing the umbilical sac, with only nominal loss. During May, however, a disease appeared among the 12,000,000 fry remaining on hand at that time, and it soon became epidemic, causing a serious mortality. All of these fry appeared normal at the time of hatching, the trouble appearing just prior to the feeding stage, and in no instance was the disease responsive to the usual methods of treatment. There was some evidence that a similar affection obtained among the migrating sockeye fingerlings at this time, and examples of the fish from the lake and the hatchery troughs were forwarded to the division of scientific inquiry for examination.

With the purpose in view of reserving Letnik Lake solely for the spawning of the sockeye salmon, the dam at the falls in Letnik River was closed on August 25 and rendered effective service during the fall and early winter in excluding Dolly Varden trout and silver salmon. It was planned to install a trap in the river at this point, to serve as a means for obtaining a count of the sockeyes entering the lake, but the webbing shipped from Seattle for this purpose was delayed en route. As an alternative racks were installed at the outlet of the lake, and 37,653 sockeye salmon were counted through between June 7 and July 1.

A simple method of transporting the advanced fry to suitable planting areas was tried with success. The trays containing the fry were placed on a Yukon sled, with a tarpaulin folded around them, and it was found that the young fish could be transported in this manner without loss, even when out of the water for as long as 30 minutes.

Further experience in hatching eggs in gravel resulted in the loss of the entire lot involved in the experiment. When the hatching

trough used for the purpose was opened, it was found that development had been arrested at the eyed stage, and it was apparent that the water circulation had not been adequate.

The distributions from the station consisted of 5,200,000 eyed eggs, delivered to the State of Oregon for the Columbia River, and 28,480 fingerlings and 4,100,000 fry, which were liberated in local waters.

Important items of repair work at the station during the year included the renewal of sills, flooring, and floor timbers at the west end of the hatchery, the lumber used in this work being sawed on the premises. In 37 days of operation the station sawmill produced some 60,000 feet of lumber, at a cost of $20.23 per thousand feet, including the cost of logging and delivering logs at the mill. A new water-tube boiler was installed and has proved well adapted for the work, the sawmill refuse making satisfactory fuel.

YES BAY (ALASKA) STATION.

[C. H. VAN ATTA, Superintendent.]

The repairs at this station, which prevented active fish-cultural work during 1921, were so far completed at the beginning of the fiscal year 1922 that egg collections were resumed. The spawning season of the sockeye salmon opened August 29, and between that date and September 27 a total of 51,000,000 eggs were collected. During the latter half of the spawning season fishing operations were materially hampered by excessive rains, high-water stages, and a strong river current, making it difficult to handle the seines. The first eggs of the season showed the eye spots by September 27, and by November 1 the entire lot had reached that stage. All fry hatched were held on trays in the hatching troughs until the absorption of the umbilical sac. The first plant was made in Hatchery Creek on April 10, and a considerable amount of salted salmon was distributed along the margins as a food supply. Gill nets were used to keep down the numbers of trout, and the young fish made excellent growth. Further experiments were conducted in maintaining an inclosed section of the river as a feeding area for young salmon, but the results were in no case satisfactory.

The inclosed arm of McDonald Slough was again used as a rearing pond. Two million sockeye-salmon fingerlings No. 1 were placed in this inclosure on May 11, and by July 25 these fish had increased in size approximately 100 per cent. The screens were removed on September 10. In December further plants of eyed sockeye-salmon eggs to the number of 150,000 were made in Round Lake and Lake No. 2, though subsequent visits to these lakes in May and June following failed to indicate that any results had followed these or previous plants in either lake.

In connection with the sockeye-salmon egg collections, 246,000 eggs of the humpbacked salmon were taken between August 22 and September 2, producing 210,000 advanced fry for distribution.

The new water-supply system installed during the previous year functioned satisfactorily, with the exception of a period of unusually cold weather with low-water stages in the river. During this period anchor ice was a serious source of annoyance, though

no loss of eggs or fry occurred. The condition was remedied by deepening the channel from the river to the intake reservoir and covering exposed portions of the pipe line.

BAKER LAKE (WASH.) STATION AND SUBSTATIONS.

[J. R. RUSSELL, Superintendent.]

Fish-cultural operations were conducted at seven points in the Washington field, and included the propagation of all species of the Pacific salmon and the steelhead. The year's egg collections for this group of stations numbered 53,978,000, and the output of eyed eggs and young fish amounted to 41,113,770, all but about 6,000,000 of this number consisting of fish varying from 1 inch to several inches in length.

BAKER LAKE (WASH.) STATION.

The buildings in course of construction at the Baker Lake station at the beginning of the year were completed and painted. The new hatchery at this point is 130 feet long by 56 feet wide, and is equipped with 150 standard salmon hatching troughs, each 16 feet long by 14 inches wide, inside measure. It has a capacity of 30,000,000 sockeye-salmon eggs, or of 25,000,000 fry when the stacked-tray system is used. The construction of the fish trap undertaken last season at the outlet of Baker Lake was completed. This trap, which is about 350 feet long, was formed by driving piles at 8-foot intervals, beginning at each shore about 50 feet below the trap proper and leading to a V-shaped point, comprising the entrance. The piles were cut off at a level of 10 feet above the average water stage and capped with 2 by 14 inch planks. The 4-inch mesh web used to obstruct the passage of the fish is hung from the top capping of the piling and extends to the river bottom, where it is held down by a heavy chain sewed to its lower edge and further reinforced by driven stakes. The trap proper is a web pot, 18 by 20 feet in dimensions, which is connected with the leads by a tunnel made of webbing. The trap is kept in position by means of lines attached to the piling, and hand windlasses are provided for raising and lowering it. Although there was a slight decrease in the collection of both adults and eggs of the sockeye salmon, which is the principal species handled at the Baker Lake station, the results of the year's work were, in general, satisfactory, both as regards losses and the condition of the fish released from the hatchery.

There was no deviation from the methods of previous years in the work of capturing, towing, and handling adult salmon, and during the time they were held in the inclosure at the head of the lake awaiting the ripening of their eggs the death rate was very low. There was no loss whatever from floods, though the water stage at one time attained a height of 14 feet above normal.

Adult sockeyes were removed from the trap between the dates of July 2 and August 27, the total capture comprising 7,075, of which 3,186 females produced the season's stock of 10,275,000 eggs. During the spawning season, which extended from October 4 to November 24, the fish were assorted every five days and all eggs were taken in the

inclosure and transferred in tubs and pails to the hatchery. Salt solution was employed to remove infertile eggs, and the stack-tray system was effectively utilized for holding fry through the yolk-sac stage.

More silver salmon entered Baker Lake than in any year since 1915. Of a total of 4,000 adults of this species taken from the trap between September 22 and November 1 there were 2,009 females, which produced 5,750,000 eggs, an average of 2,862 per fish. Following the policy of the past two years the eggs were held at Baker Lake until the eyed stage of development and were then transferred to Birdsview substation, the losses in the meantime amounting to 4⅓ per cent.

BIRDSVIEW (WASH.) SUBSTATION.

Fish-cultural work at Birdsview included operations with four species of the Pacific salmon and the steelhead. All fry hatched from eggs collected at this point were reared to fingerlings before being liberated in the principal tributaries of the Skagit River, in locations that appeared to afford the best protection from predatory birds and animals. A lot of 37,980 young chinook salmon carried over from the previous fiscal year were fed until September 20 and liberated in the No. 3 fingerling stage. As there was not sufficient water in Grandy Creek during September to permit chinook salmon to enter, the majority of the run spawned in the Skagit River below. Consequently, the egg collections declined in numbers as compared with the preceding year, the total for the season amounting to only 313,000. This stock was augmented by the receipt of 250,000 advanced fry from the Washington State fisheries department, and the fish resulting from both sources were liberated as fingerlings in tributaries of the Skagit River. A lot of 746,500 young silver salmon that were being carried in hatchery ponds on the first of the year were liberated during July, August, and September in the Nos. 2 and 3 fingerling stages. Silver salmon, believed to be the result of plants from eggs transferred from the Baker Lake station, appeared at the trap early in September. Their appearance indicated that fully a month would be required for the full development of their eggs, and, as there were no facilities for holding the fish, they were liberated above the trap and allowed to work their way farther upstream.

Between the 16th and 24th of September 141,000 eggs were collected from the run of humpbacked salmon in Grandy Creek. Though small, this number is nearly twice as large as that obtained from this stream in 1919. The majority of the humpbacked salmon entering Skagit River make their ascent during August and September, when the streams in the vicinity of the hatchery are at a low stage. Consequently, most of the fish proceed up the river some distance above the station before spawning. The principal spawning ground of the humpbacked salmon in the Skagit River lies between Rockport and Marblemount, from 15 to 20 miles above Birdsview. On May 17, 40,000 young sockeyes that had been carried over from the previous year were liberated in Grandy Creek. Though the fish received but little care during the winter and their diet was confined to canned and spawned-out salmon, the losses on the lot from the beginning of

the fiscal year to the time of planting amounted to only 7,000. They had attained an average length of 4 inches at the time of planting. From a stock of 48,000 eggs and 34,000 fry of the steelhead on hand at the beginning of the fiscal year 78,000 No. 2 fingerlings were reared and distributed during the fall in various lakes and streams in the State of Washington. Egg collections of this species began on March 30 and ended May 29, with a total of 519,000, this number exceeding last year's collection by nearly 200,000.

DUCKABUSH (WASH.) SUBSTATION.

It is estimated that during late August and early September a sufficient number of chum salmon entered the Duckabush River to permit of a collection of 15,000,000 eggs. Unforunately, it was impossible to capture more than a small percentage, as nearly three-fourths of them escaped over the traps during a period of high water. Fishing and spawning operations were conducted from August 30 to September 20, and 4,501,000 eggs were secured. A second run of this species occurred about the middle of November, but the water stages were even more difficult, and only 140,000 eggs were taken. From a small run of humpbacked salmon entering the river with the early chums, a collection of 874,000 eggs was made. Silver salmon operations included the planting of 109,000 fingerlings No. 2, carried over from the stock of the previous year, and the collection of 537,000 eggs, the latter being obtained at irregular intervals between November 28 and March 11. As a rule, silver salmon ascend the Duckabush throughout the winter, individuals frequently being seen as late as May 1. The fish are hard to capture, however, as they travel mostly on high-water stages and easily escape the traps. Therefore, while the collection made is a fair average for the station, it does not represent more than 20 per cent of the total run. The product of these eggs was returned to the river in the fingerling Nos. 1 and 2 stages. The year's output from this hatchery also included 78,000 steelhead fingerlings No. 1, which were liberated in the Duckabush River and adjacent tributaries.

BRINNON (WASH.) SUBSTATION.

From chum salmon entering Walcot Slough on flood tide and caught with a seine on the ebb 10,790,000 eggs were taken, the collections commencing on November 22 and ending December 31. As fish were still running at the rate of several hundred per day after the collections had been discontinued, the trap pickets were removed to allow them to pass unhindered to the spawning grounds above. After development to the eyed stage most of the eggs were transferred to the Duckabush substation to be hatched, and 75 per cent of the product was returned in the advanced fry stage for liberation in the slough. From the eggs retained at the station 1,040,000 advanced fry were produced. For the first time since fish-cultural work was undertaken at Brinnon a small collection of silver-salmon eggs was obtained. The run of this species is believed to be the direct result of annual plants of young salmon made by the bureau in the slough in recent years.

QUILCENE (WASH.) SUBSTATION.

The early run of chum salmon in the Quilcene River was above the average of the past three years. The second run was also large, though most of the fish escaped, as the trap was rendered ineffective by the prevailing high-water stages. The spawning season of this species began on August 17 and terminated December 20, with a total collection of 7,488,000 eggs, this number exceeding by nearly half a million the collection of the previous year. After the resulting fry had reached the free swimming stage they were transferred, in accordance with the usual custom, to ponds from which the screens had been removed and allowed to pass out at will. As a rule the fish leave these ponds in from four to six weeks' time.

Silver-salmon eggs to the number of 565,000, secured between October 17 and March 29, represent only about 20 per cent of the season's run of that species in the Quilcene River, most of the fish ascending during high-water periods and escaping the traps. Steelhead eggs to the number of 83,400 in the Quilcene hatchery at the opening of the year were developed to the No. 1 fingerling stage and released in Hood Canal. The spring collection of steelhead eggs, made between February 27 and June 7, and amounting to 745,000, was the largest in the history of the station. All fish taken in connection with this work were green at the time of capture and were therefore transferred to station ponds for the complete development of their eggs. Some of the eggs taken were shipped in the eyed stage to eastern hatcheries; the product from the remainder will be returned to parent waters.

In the course of the year a water-supply system for domestic use and fire protection was provided for this substation. A supply tank was installed on the hill opposite to and 55 feet above the foreman's cottage and was supplied with water from the creek by a hydraulic ram. From the tank the water is piped to the various buildings on the reservation.

SULTAN (WASH.) SUBSTATION.

This hatchery was open the entire year, and its work included operations with the chinook and silver salmons and the steelhead. All fry hatched are transferred in the yolk-sac stage to temporary ponds, formed by damming the overflow from the hatchery at various points. Here they may remain or pass out at will, no screens obstructing the outlets. Egg collections of the chinook salmon depend almost entirely upon the water stages in Elwell Creek. If the creek is low in September and October, very few fish can enter; but in the case of normal water stages good collections may be expected. As the former condition prevailed in the fall of 1921, the number of eggs taken was below the average, amounting to only 155,000. Approximately 100,000 silver-salmon fingerlings No. 1 carried over from the previous year were liberated in the creek during July. Egg collections of this species to the number of 2,304,000 were made at intervals from October 20 to March 13, hatched with only normal losses, and the resulting fry distributed in local waters tributary to the Skyhomish River. In July and August 104,400

FIG. 1.—Bureau of Fisheries salmon hatchery at Quilcene, Wash., with rearing ponds in foreground.

FIG. 2.—Bureau of Fisheries trout hatchery at St. Johnsbury, Vt.

young steelheads on hand were released in Elwell Creek, and during the succeeding spring 215,000 eggs of that species were collected, the spawning operations extending from April 1 to June 2.

QUINAULT (WASH.) SUBSTATION.

The usual summer operations for the rescue of fish from drying streams of the region had to be omitted, owing to pressure of other work. The first sockeye-salmon eggs of the season were taken October 25, and a day or two afterwards a heavy rainstorm flooded the trap, tearing out two sections of the rack and liberating most of the impounded salmon. Before water conditions again became normal another storm of even greater severity flooded the Quinault River and surrounding streams a second time, putting an end to collections for the season, the last eggs being obtained on December 20. Of the 4,100,000 secured approximately one-third were taken from streams other than Big Creek, which has heretofore been one of the principal sources of egg supply for the Quinault hatchery. Nearly 750,000 eggs were taken from fish caught in a small trap in one of the minor creeks near the hatchery, and a much larger percentage than usual was obtained from several of the smaller tributaries of Quinault Lake and Upper Quinault River. Two of these streams that had been racked for several years without any material results were this year filled with brood salmon. A point of interest is the extremely large proportion of small male fish everywhere present in the run.

In connection with the sockeye operations 2,050,000 silver-salmon eggs were taken, constituting the largest collection of that species since 1918. It is believed the run of silver salmon exceeded the large run of last year, but that most of the fish continued up the main river to their natural spawning grounds. On several occasions during the run of this species efficient work was possible with dip nets, and at one time two men were kept busy throughout the night in dipping operations. In an effort to reduce the considerable loss of silver-salmon eggs incident to transportation heretofore experienced a portion of the spawn was delivered to the hatchery in the milt, but without any discernible improvement.

During the early half of November 50,000 eggs of the chinook salmon were taken, this collection being nearly 100 per cent greater than that of last season. It has been observed that the main portion of the run of this species entering the mouth of the lower Quinault River spawn before reaching the lake, and during the time that sockeye spawn is being taken very few chinooks are in evidence.

The eggs and fish of the various species were handled in accordance with the methods that have been successfully employed in previous years. Owing to the clear, cold weather prevailing, the incubation period of all species was considerably prolonged. That of the sockeye salmon consumed 140 days, or 30 days in excess of the time required under more normal temperatures, while the hatching of the chinook and silver-salmon eggs was delayed 15 days beyond the usual time. As in former years, the fry were transferred to outside ponds on reaching the swimming stage and were held and fed until the

development of younger lots necessitated their liberation. At the end of the year nearly a million sockeye fingerlings were on hand, it being the intention to hold them for liberation about August 1, providing water facilities permit.

In view of the criticism to which the work of this substation has been subjected from certain sources, it may be of passing interest to estimate the proportion of the total run of sockeyes that came under artificial propagation during the season by escaping the commercial fishing activities in the Quinault River and passing into Quinault Lake, where they were available for reproduction. It was the original plan not to conduct fish-cultural operations during the fiscal year 1921, but to obtain an accurate count of the sockeyes entering the lake to afford a comparison of the results of artificial propagation as against natural reproduction. As a result of certain defects in the counting weir as installed the exact number of sockeyes entering the lake could not be ascertained, and the figures are based to some extent upon estimate. Although no actual count of the fish spawned in connection with egg collections for the hatchery was made the data available are sufficient to afford a reasonably accurate estimate.

The number of sockeye salmon counted into Quinault Lake from April 14 to June 10, 1921, was 11,788. From June 10 to the end of the run it was estimated that 8,000 additional fish entered the lake, bringing the total run for the season up to 20,000 fish, in round numbers. Assuming that half of these were females, and placing at 2,000 the number of eggs produced by each female, there would have been available some 20,000,000 eggs. Comparing this with the number of eggs actually obtained for artificial propagation—4,100,000—it would appear that only about 20 per cent of the total number of spawning fish entering the lake came under artificial propagation; and though high water and storms interfered with the work to a considerable extent the conditions prevailing throughout the egg-collecting period may be said to represent an average season.

Since the efforts to obtain an accurate count of the sockeye salmon entering the lake in 1921 were not successful, profiting by the experience gained, the necessary alterations in the weir were made in advance of the season. The counting of the 1922 run of fish commenced on March 29, and the daily tally from that date to June 30 is given in the following tabular statement:

Daily count of sockeye salmon entering Quinault (Wash.) Lake during the fiscal year 1922, showing number of fish marked by gill nets each day.

Date.	Number of fish.		Date.	Number of fish.		Date.	Number of fish.	
	Total counted.	Marked by gill nets.		Total counted.	Marked by gill nets.		Total counted.	Marked by gill nets.
Mar. 29	65	.....	Apr. 7	194	.....	Apr. 16	171	14
30	42	.....	8	483	.....	17	130	17
31	185	.....	9	197	.....	18	139	12
Apr. 1	200	.....	10	91	4	19	125	18
2	188	.....	11	122	6	20	143	18
3	349	.....	12	60	4	21	174	27
4	591	.....	13	97	5	22	159	23
5	860	.....	14	190	15	23	177	22
6	316	.....	15	147	12	24	187	27

Daily count of sockeye salmon entering Quinault (Wash.) Lake during the fiscal year 1922, showing number of fish marked by gill nets each day—Continued.

Date.	Number of fish.		Date.	Number of fish.		Date.	Number of fish.	
	Total counted.	Marked by gill nets.		Total counted.	Marked by gill nets.		Total counted.	Marked by gill nets.
Apr. 25	218	27	May 18	2,341	195	June 10	3,918	314
26	130	27	19	432	37	11	4,114	639
27	243	42	20	1,175	204	12	4,272	622
28	289	36	21	1,056	144	13	13,987	1,497
29	410	44	22	996	168	14	8,738	783
30	250	48	23	3,571	525	15	7,109	728
May 1	173	33	24	3,403	217	16	5,650	597
2	358	57	25	3,996	288	17	2,327	140
3	870	163	26	2,334	180	18	1,336	48
4	1,039	98	27	2,351	365	19	1,202	44
5	1,323	143	28	5,512	469	20	841	34
6	901	78	29	5,261	269	21	1,258	33
7	922	107	30	9,569	854	22	781	78
8	216	37	31	17,840	1,500	23	765	39
9	1,106	147	June 1	8,649	721	24	709	25
10	1,868	139	2	4,812	287	25	910	26
11	1,200	99	3	3,047	321	26	1,699	40
12	996	63	4	5,262	283	27	1,328	33
13	874	95	5	4,051	281	28	1,457	22
14	719	43	6	9,189	1,199	29	1,094	15
15	1,111	62	7	6,238	566	30	2,292	25
16	1,201	127	8	4,206	368			
17	1,896	184	9	4,316	389	Total	199,489	17,735

An interesting point developed in connection with the count, and one suggesting the desirability of a change in the existing regulations governing fishing in the Quinault River, is the very large number of fish showing gill-net marks. The numbers thus marked, representing approximately 9 per cent of the total count, are indicated in the table. The abrasions were of such a nature that it seemed certain that fully 50 per cent of the fish could not survive to the spawning period. In fact, every day during the latter part of the run considerable numbers of dead fish were removed from the upper side of the weir and many others were observed along the shores of the lake. These dead fish led to some criticism of the counting work, certain uninformed persons believing that the fish received their injuries at the weir. From the information at hand it appears that the trouble arose from the practice of setting gill nets of too large mesh in the mouth of the river, where the fish previously enmeshed are drawn through the nets by the strong current on the ebb tide and the motion of the sea on the bar. It is alleged that many of the fish thus injured fall prey to seals, while others, evading the nets on the second entry to the river, reach the lake in the condition described. With the view of obviating the resulting heavy wastage it was proposed to dispose of these gill-net marked fish through the Indian Service, but so many objections were raised against the project by Indians and fish buyers of the region that the plan was abandoned.

It is conceded by most observers that the run of sockeye salmon during the season equaled the large run of 1915. All of the Indians engaged in fishing made excellent catches and received large monetary returns. During the peak of the run Indians using dip nets

were able to take as many as 300 fish per day, while those operating gill nets received from $200 to $300 per day for their catches. A uniform price of 50 cents per fish regardless of size was paid by the buyers throughout the season.

CLACKAMAS (OREG.) STATION AND SUBSTATIONS.

[HUGH C. MITCHELL, Superintendent.]

Though fish-cultural operations in the Oregon field were materially handicapped at several points by high water and loss of racks during the spawning season, the general outcome of the year's work is regarded as satisfactory. Both the spring and fall runs of chinook salmon were equal to expectations throughout the field, except on the Rogue River and in Idaho on the Lemhi. The egg collections at Clackamas and its nine substations amounted to 63,685,850, of which 57,885,100 were chinook salmon. This makes a favorable comparison with last year's total of 42,912,000 eggs taken at all points. Young salmon to the number of 51,446,800 were retained for rearing at the various hatcheries, but at several points the stock held was found to tax the existing facilities too heavily for the best results and considerable numbers were of necessity liberated when only from 1 inch to 1.5 inches long. Aside from these rather premature plantings rearing and feeding operations were carried to a successful conclusion, the losses being normal and all fish released in a healthy condition. The usual quantities of salted salmon were prepared at all points for fish food.

CLACKAMAS (OREG.) STATION.

At Clackamas station, where chinook-salmon eggs are secured under contract, fishing and spawning operations began on September 19 and continued to October 28, when a sudden rise in the river permitted all fish held below the racks to escape, putting an end to the season. The egg collections numbered 7,636,800, and it is estimated that they might have been increased by at least 25 per cent had it been possible to hold the fish two or three weeks longer. With the exception of two days at the most critical period, the eggs in the hatchery were carefully picked over daily, regardless of the stage of development. It appeared that the loss of eggs was lessened and the quality of the fry improved by this method. In addition to the salmon eggs secured locally, several shipments forwarded from the Little White Salmon and the Sandy River stations were received and cared for.

As a result of some tests made, with the view of determining the proper amount of food to be given young salmon, it seems probable that a given number of fish can be successfully carried on a smaller quantity than has heretofore been deemed essential at this station. The experiments also seemed to indicate that the young fish receiving food twice each day made as rapid growth as those receiving nourishment four and six times daily and were equal to them in other respects. The essential requirement in using the smaller amount appears to be that the food must be supplied slowly and distributed in the troughs evenly in small amounts at each feeding.

Fish thus treated showed no signs of "nipping," which is an indication of insufficient food and is frequently troublesome in trough-fed fish.

Transfers of eggs of other species to Clackamas station included a consignment of 50,000 black-spotted-trout eggs from the Yellowstone National Park; 400,000 brook-trout eggs from Springville, Utah; and 50,000 rainbow-trout eggs from the Madison Valley (Mont.) field. The fry resulting from all these were on hand at the close of the year.

UPPER CLACKAMAS (OREG.) SUBSTATION.

On the Upper Clackamas River, where fishing and spawning operations were conducted from August 23 to September 13, the results in eggs collected did not equal those of last season, owing to a lighter run of fish and to illegal fishing. Eggs to the number of 841,300 were secured, and these, together with 1,450,000 eyed eggs forwarded from the Little White Salmon hatchery, produced 2,111,000 fingerling salmon for liberation in local waters. There was at no time any extraordinary loss of either fish or eggs, though once during January the water was suddenly reduced and the hatchery had to be operated on a minimum supply for a period of four and one-half hours. Taken as a whole, the season was a very satisfactory one, aside from the fact that liberations of stock had to be made from time to time at an earlier period than was desirable, in order to relieve congestion. In future the retaining rack at this station will be installed 500 yards farther downstream than heretofore, with the view of including an existing eddy within the inclosure as a place of rest and protection for spawning salmon. It is anticipated also that the take of eggs will be somewhat increased by this change.

LITTLE WHITE SALMON (WASH.) SUBSTATION.

In the face of a light run of salmon and a pack slightly below the average, it is gratifying to report that brood salmon in unusual numbers made their appearance at the bureau's stations on the Columbia River and all conditions during the fishing season were favorable. Eggs were taken on the Little White Salmon River from September 19 to October 20, amounting to 33,641,000. Soon after the close of the spawning season a severe storm broke, filling the watercourses with coarse hail and converting the streams into ice packs. One flume was carried away by a snow and hail slide, and later on the main flume ceased to function temporarily, being pushed out of line and otherwise damaged. However, through the exercise of intelligent and persistent effort the small flume was replaced during the night and the main one patched to serve out the season, though the entire system will have to be extensively repaired in advance of next season's operations. The roads were blocked for months after the storm, rendering inoperative to some extent the plan of relieving congestion in the hatchery by the transfer of eggs to other units. For this reason more fish were produced than the available space would accommodate, and though all of them were fed for a time a considerable number had to be released in the No. 1½

fingerling stage. The moderately even cold weather prevailing throughout the winter kept the water temperature at a low point, retarding development and growth of the fish and probably lowering the average size of the salmon liberated as compared with last year's output. Eyed eggs to the number of 6,650,000 were transferred to the Clackamas station and to Big White Salmon and Upper Clackamas substations, and 1,400,000 were furnished to the Oregon and Montana State fisheries departments.

Excavations made in advance of the season for four large raceways on the flat at the west of the lower hatchery proved so eminently suited to the work of holding young salmon that a plan for replacing the entire pond system by roughly excavated raceways is now being considered. During the season the fish in the station inclosure were closely inspected by one of the most expert buyers on the Columbia River, who pronounced them spring-run chinooks and not fall fish.

BIG WHITE SALMON (WASH.) SUBSTATION.

During the spawning season, extending from September 3 to October 12, 12,025,000 chinook-salmon eggs were taken, 8,000,000 of them being secured from fish entering Spring Creek fishway. The establishment of this excellent run of salmon in Spring Creek, which shows an annual increase, is of interest since that tributary was not a natural salmon stream, the present runs being the result of fingerling fish introduced therein from the Big White Salmon hatchery. This stream is of further interest, since it is affording a convenient source of salmon eggs for the hatchery. The Big White Salmon is a difficult stream in which to conduct operations, being deep and swift and offering every chance for fish to evade the seines. During the winter of 1921–22 the fishway in Spring Creek was extended, making it less difficult for the fish to enter.

Departing from the usual custom of stripping at the fishing grounds the salmon taken in the Big White Salmon River, such fish during the past season were killed at the trap and hauled to the hatchery before taking the eggs. By this means the transfer of eggs down the Columbia River in skiffs, with the consequent heavy losses during the heavy seas often prevailing, is obviated.

Through the transfer of eyed eggs from the Little White Salmon substation the stock was increased to 15,625,000, which were hatched with merely nominal losses. The resulting fry were placed in Spring and Hatchery Creeks and fed until they were from 2 to 3 inches in length. This is the first season that Hatchery Creek has been so utilized. The results were such as to warrant a continuance of this method of feeding.

ROGUE RIVER (OREG.) SUBSTATION.

Much difficulty was experienced in connection with the installation of racks at this point, the equipment being carried away twice by freshets from melting snows during the early summer. The work of replacing them for the third time was completed on August 12, on which date fishing and spawning operations were undertaken and

continued daily until October. The total collection of chinook-salmon eggs for the season amounted to 1,665,000, which is considered satisfactory in view of the conditions referred to above. The run of silver salmon in all tributaries of the Rogue was light, and from collecting operations conducted at Elk Creek Dam only 94,500 eggs were realized. The steelhead work at this point included the rearing and liberation in local waters of some 100,000 fingerling fish produced from eggs obtained the previous year and the collection of 347,500 eggs between February 17 and May 15. Eggs of this species to the number of 1,943,000, transferred from the Applegate Creek field, were also hatched, and the resulting fry are being reared to the fingerling stage.

It is evident that a considerable number of the spawning steelheads escape over the Low Elk Creek Dam, and as it is impossible to increase its height without endangering the county road an effort will be made to overcome the difficulty by adding an apron to the dam during the coming summer when the stream is at a low stage.

A serious wind and rain storm passing over southern Oregon in November damaged both current wheels to such an extent that the station water supply was entirely cut off for two days, necessitating the immediate liberation of all fish on hand. The eggs in the hatchery were saved by holding them in a hastily constructed temporary battery on the west side of Elk Creek until repairs could be made. In preparation for fish-cultural operations during the succeeding year the rack was reconstructed across the Rogue River in April and washed out by a freshet the following month. It was replaced in June, and at the end of the year a sufficient number of chinook salmon were in evidence below it to produce a normal season's egg collection.

APPLEGATE CREEK (OREG.) SUBSTATION.

Fish-cultural work at this point was confined to the propagation of silver salmon and steelheads. During the spawning season of the former, extending from November 29 to January 7, the water stages were low and the weather cold. Consequently, only a few fish made their appearance and the egg collections were light, the total being only 113,000.

Because of its ineffectiveness during the past three years, the fin rack used at this point was converted in advance of the steelhead spawning period into a solid dam. The racks were removed, and after reinforcing three of the piers the spaces were spanned by heavy timbers and logged, this change necessitating the raising of the wings 12 inches. This somewhat extensive improvement was made at a comparatively light cost, and although a number of steelhead trout succeeded in their efforts to surmount it, it is believed this may be prevented in future by the construction of an apron to break the direct fall of water. Steelheads are fish of a most persistent nature. Arriving as they do when the rivers are high, they are very difficult to capture, and unless the obstruction encountered is absolutely fish proof they will effect their escape. Numbers of them were seen surmounting the dam the past season, though the obstruction was 8 feet high, and the nearly perpendicular stream of water falling over it was more than 16 inches in its smallest dimension.

Egg collections of the steelhead trout were made from February 24 to May 8. There was a good run of fish, notwithstanding the somewhat unfavorable climatic conditions prevailing, and 3,673,000 eggs were secured. After developing them to the eyed stage nearly 2,000,000 were transferred to the Rogue River substation for incubation, and shipments comprising a total of 200,000 were furnished to the State fishery departments of New York, Minnesota, and Pennsylvania, and to the bureau's Bozeman (Mont.) station. The remainder were hatched, with the view of rearing the resulting fish to the fingerling stage for distribution in the parent waters.

SANDY RIVER (OREG.) SUBSTATION.

With the view of determining the fish-cultural value of this field, operations were undertaken late in July at the abandoned State hatchery, located below the hydroelectric dam on the Sandy River, near Marmot, Oreg. A rack was hastily thrown across the river to intercept the fish still running, and chinook-salmon eggs to the number of 1,637,000 were obtained between August 18 and September 10. These were held until eyed, the losses being unusually heavy because of an inadequate water supply, and were then transported to the Clackamas station to be hatched. While the work with the chinook salmon was still in progress a heavy run of silver salmon was observed, but, as no preparations had been made for work with that species, egg collections could not be undertaken, and the substation was closed for the season on October 1. In the month of March an employee was stationed at Sandy River to determine the size of the run of steelheads and black-spotted trout, and incidentally, at little expense, he obtained 634,000 steelhead eggs.

With the experience gained the advisability of conducting operations at this location is no longer questioned, and preparations for the improvement of the hatchery and the proper handling of the stock will be started next season in due time.

SALMON (IDAHO) SUBSTATION.

The importance of the Salmon River region in connection with the valuable commercial fishes of the Columbia River Basin having been recognized from the experience gained in the fish-cultural work of past years and the more recent investigations, it was decided to develop fish-cultural operations there and not confine the work to egg collections only. The Salmon River with its tributaries and the beautiful glacial lakes that they drain constitutes a most important natural nursery for salmon and trout. On account of its rugged topography, inaccessibility, and lack of agricultural land much of this territory, and particularly the portion that is drained by the South Fork and the Middle Fork of Salmon River, lying within the Idaho and Payette National Forests, will probably remain undeveloped for a long period, though a highway follows through the canyon of the main branch of the Salmon River from Shoup to Stanley, a distance of 150 miles. Because of the splendid spawning areas available, in addition to the advantages mentioned above, it would seem that some measure of protection against the unsportsmanlike methods pursued by many, of spearing and otherwise dis-

turbing the fish on the spawning beds, would meet the immediate requirements in conserving fish in these waters without resorting to artificial propagation. However, conditions on the main branch of the river are different. In that section irrigation ditches are numerous, the highway affords ready access to sportsmen, and the river and many of its tributaries are heavily fished.

During the year a hatchery building 32 by 90 feet, equipped with 60 hatching troughs, and a four-room cottage for the accommodation of the person in charge, were constructed on land near Salmon, Idaho. Title to this land is vested in the State of Oregon, and its control for fish-cultural purposes has been delegated to the bureau. The site is admirably suited to such work, an abundance of most excellent spring and creek water being readily available and affording ample opportunities for rearing ponds.

Egg collections of the early-run chinook salmon were made in Lemhi Creek, a tributary of the Snake River, during the latter part of August and transferred to the Salmon substation to be hatched. Because of the flooded condition of the creek the run of salmon was due before the rack could be installed, and it is felt that large numbers of fish passed upstream before the construction could be made fish tight. The spawning period extended from August 15 to September 2, and the total egg collections amounted to 440,000. In addition to the salmon eggs taken in Lemhi Creek, 50,000 rainbow-trout eggs were shipped from the Wyoming field and 150,000 eggs of the same species were received for incubation for the State of Idaho and the Salmon Rifle Club, of Salmon, Idaho. The fry resulting from all these eggs were on hand at the close of the year.

Though the Salmon hatchery was operated for the first time during the longest and coldest winter of which there is any record, the building and the water supply met all requirements and the eggs produced a high percentage of strong healthy fish for return to parent waters. This Idaho field is believed to have great possibilities, and plans are being made with the view of developing it into one of the principal fish-cultural factors in the Columbia River Basin. During the coming season racks will be built on the Lemhi and Pahsimeroi Creeks and a third eying station will be constructed at a suitable point on Sunbeam Dam.

WASHOUGAL RIVER (WASH.) SUBSTATION.

Late in March an employee was detailed to this field to make preliminary arrangements for the collection of steelhead eggs. The fishway was racked, springboards from which to dip the fish were suspended, and the retaining pens in which to hold the partially ripe fish were overhauled and launched. Eggs were taken throughout the month of May, the total aggregating 932,000. After developing them to the eyed stage, sufficient numbers to supply applicants were shipped. The remainder were incubated for local waters.

BAIRD (CALIF.) STATION AND SUBSTATIONS.

[W. K. Hancock, Superintendent.]

In this field, which is devoted exclusively to the propagation of the chinook salmon, natural conditions were very unfavorable for fish-cultural work. Owing to an unusually extended period of

drought the water stages in all streams were abnormally low, making it difficult for fish to ascend in considerable numbers. There being no run of salmon whatever in the McCloud River, on which the Baird Station is located, the hatchery at that point was stocked with eggs taken at the Battle Creek and Mill Creek substations, such transfers being necessarily postponed until after late fall rains had supplied sufficient water for the conduct of hatching operations. The first consignment of approximately 1,000,000 eggs from the Battle Creek substation was received on January 6, and shortly afterwards a second consignment of 500,000 from the Mill Creek collections was delivered. During the intense cold prevailing through midwinter the supply ditch could not be kept free of ice, and from January 19 to February 8 pumps had to be operated for maintaining a supply of water in the hatchery. Incubation was completed by March 6, and as soon as the fry had reached the proper age they were turned into several temporary ponds, formed by damming small streams in the vicinity of the station, and fed for a time on salted salmon, beef liver, and mush before being liberated in the McCloud River.

This station is very much in need of an adequate pond system for holding and feeding young salmon until they attain a desirable size before releasing in open waters. The present expedient of utilizing small stream inclosures for the purpose is unsatisfactory for several reasons, but principally because the streams become dry at the approach of summer, necessitating the liberation of the fish at an unsuitable stage of development. Adequate pond space is also greatly needed at the Battle Creek and Mill Creek substations. At the first-named point five earth ponds are available for holding salmon to the fingerling No. 2 stage, but at Mill Creek there is no pond system whatever and resort must be had to several shallow excavations in order to retain and feed a few hundred thousand fry for a limited period.

The spawning season at the Battle Creek and Mill Creek substations extended from October 22 to December 4, and a total of 6,363,000 eggs were taken. The work at both points was much below expectations, excessively low water stages seriously curtailing the results. After making the transfers of eyed eggs referred to above the product of the remaining eggs at these stations, in the form of fingerling fish, was returned to local waters.

GREAT LAKES FISHES.

Of no less importance than the work of the salmon hatcheries is that concerned with the fishes of the Great Lakes, and no line of fish culture has a more hearty indorsement of the interests involved. Without exception, as far as has been ascertained, the bureau's work in fish culture throughout the region has the unqualified indorsement of the fishing interest and of the individual fishermen, and in no section is this spirit of approbation manifested in the form of practical cooperation to a greater extent. A feature of the work that readily commends it to the practical fisherman is that all of the eggs incubated at these hatcheries are obtained from fish taken in the market fishery that otherwise become a total loss. During the fiscal year 1922 seven stations and substations on the Great Lakes and Lake

Champlain were operated with an aggregate output of about 1,040,000,000 eggs and fry of the commercial species. This figure includes the whitefish, cisco, lake trout, pike perch, yellow perch, and carp. Smaller numbers of brook trout, rainbow trout, and small-mouthed black bass were also produced, as indicated in the table on page 12. The output of these stations for 1922 is smaller by approximately 120,000,000 than in 1921, the principal difference appearing in the output of pike perch. The yellow perch was propagated also at the Bryans Point (Md.) substation.

DULUTH (MINN.) STATION.

[S. P. WIRES, Superintendent.]

Lake-trout egg collections were made at various points on the south shore of Lake Superior and at favorable points along Isle Royal as in previous years. The spawning season opened at Washington Harbor, Isle Royal, on September 25, and closed there about November 15, the collections at all stations being about 22,250,000. All of these were incubated at the station except 1,000,000 that were delivered to the Minnesota State hatchery, located at French River. Unfavorable weather conditions which prevailed for a time during the height of the spawning season resulted in an egg collection somewhat below the average in quality, but entirely satisfactory otherwise. The resulting eyed eggs, fry, and fingerlings were in excellent condition when delivered to messengers for distribution.

A total collection of 22,500,000 whitefish eggs from the Put in Bay collecting field were received, and nearly 4,000,000 more were purchased from Isle Royal fishermen at 40 cents per quart. The egg-collecting period of this species extended from October 25 to November 10, and, as in the case of the lake trout, much unfavorable weather prevailed during almost the entire spawning period. However, the quality of the eggs as a whole was fairly good, the greatest loss occurring from one lot of about 4,250,000 produced by the field station at Toledo, Ohio. The loss sustained from this particular lot was a factor, of course, in reducing the percentage of hatch among the whitefish eggs. The percentage of hatch of lake trout was about 56 and of whitefish about 66.

Because of a lack of funds pike-perch propagation was not undertaken in Minnesota waters as has been customary, and of the limited collection of eggs of the species in other fields none were available for transfer. Eyed brook-trout eggs to the number of 150,000, procured by purchase from commercial hatcheries, were hatched with only ordinary loss (about 5 per cent) and 100,000 rainbow-trout eggs that were transferred from the Bozeman (Mont.) station were hatched with a loss of less than 4 per cent. At the end of the fiscal year 90,000 fingerling rainbow trout No. 1 were on hand for distribution.

NORTHVILLE (MICH.) STATION AND SUBSTATIONS.

[W. W. THAYER, Superintendent.]

NORTHVILLE (MICH.) STATION.

From the stock of small-mouthed black bass carried over from the previous year some 21,000 fingerlings No. 3 were distributed, and the hatch of this species for the fiscal year 1922 was estimated at 200,000.

The brood stock received from Lake Erie wintered in excellent condition and was held in the wintering ponds until there was evidence of nest preparation. Spawning commenced almost immediately after transfer to the spawning ponds, and the first fry were observed on May 22, some 12 days after the first nest building was observed, the mean water temperature being about 60° F. Eggs and fry were observed in the ponds as late as June 1. Distribution was undertaken as soon as the young fish had reached the feeding stage, and by June 7 fingerlings No. 1 from the current year's hatch were available. The young small-mouthed black bass make excellent growth in the ponds at this station, and examples of fish 3½ inches long when 3 weeks old are not uncommon. There were received from the Michigan commission 103,000 rainbow-trout eggs, from which a hatch of 94 per cent was obtained, the fry and fingerlings resulting from these entering into the general distribution in the States of Michigan, Indiana, and Illinois.

CHARLEVOIX (MICH.) SUBSTATION.

Lake-trout egg collections were undertaken at the usual points on Lakes Michigan and Huron, the collecting season extending from November 1 to 25. The work yielded 44,000,000 eggs, as against 30,876,000 for the previous year. The weather conditions were generally favorable, and fishermen at most points secured satisfactory numbers of fish. The quality of the eggs taken was, however, unsatisfactory, and less than 50 per cent produced fry.

There was no important change in the unsatisfactory fishing regulations in force last season, and to this condition the poor results of the season's work both as to quantity and quality of the eggs obtained must be attributed. Whitefish eggs to the number of 46,080,000 were obtained, a satisfactory increase over the 12,080,000 taken in the same fields during the year previous. This number does not represent the full possibilities of the fields for egg collections when suitable changes in the fishing regulations become effective and funds are available for certain changes in the methods at present employed in egg collections. The collecting season extended from November 1 to December 4 and covered the usual points on Lakes Michigan and Huron, most of the eggs coming from fields in the vicinity of Alpena. The local collections were augmented by transfers from Lake Ontario and Lake Erie fields, amounting in the aggregate to approximately 50,000,000.

In addition to the lake trout and whitefish, 20,000 eggs of the steelhead from the Birdsview (Wash.) substation were incubated and the resulting fry planted in a tributary of Pine Lake.

ALPENA (MICH.) SUBSTATION.

Though this substation is located on one of the most important fishing ports of the Great Lakes, no fish-cultural operations have been attempted for several years because of the unsatisfactory nature of the water available for the hatchery. During the fall of 1922 it was decided to give this water a further trial as to its suitability for fish-cultural purposes. Accordingly, 1,500,000 lake-trout eggs and 6,000,000 whitefish eggs were forwarded in the eyed stage from the

Charlevoix station. The results of this experiment prove conclusively that the water now available at the station is not suitable for fish culture. While the lake trout seemed more resistant to the chlorinated water than the whitefish, the loss on this species was nevertheless serious.

BAY CITY (MICH.) SUBSTATION.

Pike-perch culture was again undertaken on Saginaw Bay at Bay City, Mich., and the necessary force of men was assembled on April 1. Conditions seemed normal in every respect, and the usual satisfactory collection of eggs was anticipated. The first eggs were taken on April 10, and between that date and the 18th practically the total number of 75,450,000 eggs was obtained. A violent storm occurring on the 18th and continuing for several days brought all fishing operations to an abrupt end, and the station was closed on the 25th. Most of the eggs were delivered to the Detroit hatchery of the Michigan Fish Commission, and smaller numbers were furnished to the Conservation Commissions of Indiana and Iowa. The importance of the work that may be done in Saginaw Bay in connection with the valuable pike-perch fishery and the desirability of a properly equipped station conveniently located for the incubation of the eggs available is again mentioned.

PUT IN BAY (OHIO) STATION.

[S. W. Downing, Superintendent.]

The egg collections at this station for the fiscal year 1922 aggregated 690,730,000, an increase of 128,305,000 over the year previous. The eggs were divided among the species as follows: Whitefish, 385,820,000; pike-perch, 149,980,000; yellow perch, 56,930,000; and carp, 98,000,000. Although the work addressed to the whitefish produced entirely satisfactory results, it is of interest to note the decline of the work in certain sections of Lake Erie.

In the Toledo (Ohio) field, which includes the principal fisheries from the mouth of the Detroit River down the south shore of the lake as far as Wards Canal and Turtle Creek, midway between Toledo and Port Clinton, there were produced only 16,060,000 eggs, and none whatever were obtained from the Monroe (Mich.) fields. Previous to the fiscal year 1921 these two fields yielded each year between 50,000,000 and 70,000,000 eggs. Whether or not this sudden decline in a profitable fishery is due, as many persons interested are inclined to think, to the increased volume of pollution from recently established industrial plants at Monroe, Mich., and Toledo, Ohio, the bureau is not prepared to say, but it is significant that at other points free from such possible influences a decline is not apparent. The egg-collecting season extended from November 11 to December 12, eggs being obtained from Toledo, Port Clinton, Catawba Island, North Bass Island, Middle Bass Island, and Put in Bay, all in Ohio. Of the total collection, some 98,000,000 were shipped in the green stage to other stations and about 28,000,000 were planted on the spawning grounds immediately after fertilization. These plants represented eggs of poorer quality and were necessary to provide space in the hatchery for the better eggs. The

remaining 260,000,000 were eyed by December 30. Six million of these were shipped to other stations, and 204,000,000 fry were hatched and liberated in Lake Erie within a range of 2 to 15 miles from the hatchery.

Acceding to the demands of local fishermen, the work addressed to the propagation of the carp on the Portage River and Sandusky Bay was again taken up. Owing to rough weather the spawning season opened late, but it continued correspondingly late, with very satisfactory results, the egg collections amounting to 98,000,000. All fry hatched from these eggs were deposited in the Portage River between Port Clinton and Oak Harbor, over a distance of about 12 miles.

With the advent of an early spring conditions were favorable for the spring fishing on Lake Erie on March 15, the first day of the open season, and good catches of fish were made from the beginning, a very fair per cent of them being pike perch. However, no ripe fish were observed until April 4, between which date and May 4 pike-perch eggs to the number of 149,980,000 were collected from the fisheries at Toledo, Port Clinton, and North Bass Island. Of these approximately 50,000,000 were eyed and 8,275,000 shipped to other stations. The Ohio State hatchery at Put in Bay turned over to the bureau 3,500,000 eyed eggs, and from the combined stock 46,000,000 fry were produced, of which 40,000,000 were released on the spawning grounds in Lake Erie and 6,000,000 were furnished to applicants in Indiana, Pennsylvania, and Ohio.

The spawning season of the yellow perch corresponds closely with that of the pike perch in Lake Erie, and fishermen operating for the latter were requested to save all available eggs. As a result of their efforts 56,930,000 yellow-perch eggs were secured between April 20 and May 4, of which small numbers were shipped to the Kansas fisheries department and to Washington, D. C., for exhibit. Because of the peculiar nature of eggs of this species, and the usual turbidity of the water supply in the Put in Bay hatchery during the spring, it is difficult to carry the eggs beyond the eyed stage in hatching jars. Therefore, after successfully eying them, a large number were planted on the spawning grounds and the remainder were incubated in wire baskets suspended in the bay adjacent to the hatchery. This method of incubating yellow-perch eggs has been extensively followed on the Potomac River and has given uniform satisfaction.

CAPE VINCENT (N. Y.) STATION.

[J. P. Snyder, Superintendent.]

The repairs and alterations under way at this station were practically completed. During the year an 80-horsepower Almy water-tube boiler, with all necessary accessories, was installed, thus equipping the station to supply its own hatchery water independently of the city water, which has been used in the past. Two new batteries of 396 hatching jars each were set up, giving the hatchery a capacity for incubating approximately 275,000,000 whitefish or 587,000,000 cisco eggs.

Besides making whitefish-egg collections in the usual fields near Cape Vincent, the cooperative arrangement with Canadian au-

thorities was continued, whereby the bureau's spawn takers are allowed to collect whitefish and cisco eggs in certain Canadian waters of Lake Ontario. Because of the worthless conditions of the boats available, the attempt to collect eggs in the Bay of Quinte was a failure. This is merely a repetition of former years' experience, and it further demonstrates the necessity of having a suitable boat in order to successfully cover this important field. From all fields an aggregate of 187,420,000 whitefish eggs were secured, of which 126,349,000 were shipped, in the green stage, to Canada, to New York and Pennsylvania State hatcheries, and to the bureau's substation at Charlevoix, Mich., and central station at Washington, D. C.

Many eggs taken and fertilized by fishermen were not secured, for the reason mentioned (the worthless condition of available boats), and for the same reason some 170,000,000 eggs taken by the bureau's spawn takers were planted on the spawning grounds. Of the eggs retained at the hatchery 507,500 in the eyed stage were shipped to applicants, and the 31,500,000 fry resulting from the remainder were distributed in Lake Ontario, as were also the fry produced from the eggs furnished the New York and Canadian hatcheries. Among the whitefish eggs received from Canadian waters were 2,000,000 taken from fish caught and held in pound nets. These were secured under unusually favorable conditions, and 70 per cent of them were successfully incubated. Cisco eggs were taken in practically the same waters in which the whitefish operations were conducted, but with Sodus Bay and Fairhaven Bay, N. Y., in addition, the total from all points amounted to 429,900,000. Of these 212,190,000 were planted as green eggs in public waters, or apportioned among the hatcheries of Pennsylvania, New York, Maryland, and Michigan; 5,000,000 eyed eggs were delivered to the Michigan Commission, and fry to the number of 47,400,000 were hatched and planted in Lake Ontario. Acting with the consent and advice of the New York Conservation Commission, pound nets were set in Henderson Bay, with the view of ascertaining the possibility of obtaining eggs from waters closed to commercial fishing, but the results were negative.

Lake-trout eggs were collected at Pigeon Island, Ontario, and Stony Island, N. Y., as in former years, the total amounting to 818,000, from which a 71.7 per cent hatch resulted. Adult yellow perch were collected by the use of trap nets from the St. Lawrence River and carried in tanks in the hatchery until ready to deposit their eggs. From this source 11,655,000 eggs were obtained and incubated, and fry to the number of 10,000,000 were hatched and liberated in small bays along the river.

Brook trout and rainbow trout also entered into the distribution from this station, eggs of these species being obtained either by purchase or by transfer. Brook-trout eggs to the number of 360,889 were received from the bureau's Springville (Utah) station, and 288,000 were purchased from the Brookdale Trout Co., of Kingston, Mass. Owing to the development of fungus on the young fish, probably because of impurities in the water supply, the mortality was alarming for a time, but after immersing in a strong salt solution and transferring them to the village water-supply the disease disappeared.

SWANTON (VT.) SUBSTATION.

[A. H. DINSMORE, Superintendent.]

Fish-cultural work on Lake Champlain during the spring of 1922 was a dismal failure, because of the effects of the unprecedentedly high-water stages in the Missisquoi River and the lake. The Swanton station was opened March 30, and the first pike perch were taken on April 13. Almost immediately afterwards heavy rains and melting snow brought about flood conditions, abruptly ending all fishing operations. In all, 36,737,000 pike-perch eggs were secured. Following the close of this work 16,200,000 yellow-perch eggs were collected and successfully hatched.

BRYANS POINT (MD.) SUBSTATION

[L. G. HARRON, Superintendent.]

Most excellent results were obtained in connection with the work of propagating the yellow perch at this station. Between the 3d and 14th of March 21,620 adult fish of this species, ranging in length from 6 to 9 inches, were collected and placed in live boxes. Approximately 75 per cent of them were females, and in the course of the two weeks beginning March 14 they deposited naturally in the live boxes 199,660,000 eggs of fine quality. Some 6,250,000 were supplied to other stations of the bureau and to applicants. The remainder produced fry to the number of 168,102,000, all of which were distributed in the principal tributaries of the Potomac with the exception of 3,000,000, used in supplying applicants in Pennsylvania.

CONSIDERATIONS CONCERNING WORK OF GREAT LAKES STATIONS.

MORTALITY IN PIKE-PERCH EGGS.

Every fish-culturist whose work has brought him in contact with the incubation of pike-perch eggs is aware of the high percentage of loss almost invariably sustained, and most of them will doubtless agree that a 50 per cent hatch may be considered fairly successful. The subject has been the ground for several investigations, but no definite conclusions have ever been reached nor any practical remedies suggested. In the most recent report[3] on studies of this important point in fish culture, Dr. Franz Schrader and Sally Hughes Schrader conclude that the high death rate is not caused principally by lack of impregnation, as seems to have been generally supposed. They attribute the most important cause to the agency that manifests its presence in abnormalities occurring during the early stages of development, which must lead either to malformation or death. They believe that this agency may be traced to the practice of retaining captured fish in artificial inclosures, pending the maturity of the eggs and sperm; that the same condition may be induced in fishes retained for undue periods in the fishing appliance used in their capture; that the present methods, mechanical or otherwise, but ad-

[3] Mortality in Pike-Perch Eggs in Hatcheries. By Franz Schrader and Sally Hughes Schrader. Bureau of Fisheries Document No. 926, Appendix V, to the Report of the U. S. Commissioner of Fisheries for 1922, Washington, 1922.

mittedly crude, that are used to prevent cohesion are also responsible for a certain percentage of the mortality; and that extreme care in the stripping process and in the application of the means to overcome cohesion may reduce the loss to a considerable extent.

PROPER METHODS OF TAKING, FERTILIZING, AND CARING FOR EGGS OF WHITEFISH AND CISCO.

Every year an increasing number of fishermen undertake to secure for delivery at the hatcheries the mature eggs of the fish taken in their operations. In certain remote sections of the Great Lakes eggs that they are unable to deliver at a hatchery are taken and fertilized by fishermen. Every possible effort is made to furnish a boat or other means for transporting all eggs secured to the nearest hatchery, but with the limited facilities at present available it can not always be arranged to visit all points where eggs are available within a reasonable time, hence the fullest value of this cooperation is not always realized. As the value of eggs for artificial propagation depends to a considerable extent upon the methods used in obtaining, fertilizing, and caring for them prior to their installation in a hatchery, the following suggestions are offered for the advice of interested persons:

The prospective spawn taker should have a pan, a dipper, and a number of wooden kegs or cans in which to place the eggs after fertilizing them, these articles to be supplied from the nearest hatchery. As soon as spawning fish are available rinse and drain the pan, wipe the excess water and slime from a female fish by passing the hand gently over the abdomen. Hold the fish as close to the pan as possible and express the eggs from it by gentle pressure, working from just above the pectoral fins toward the vent. Eggs that are ripe and in condition for incubation will flow freely from the fish under slight pressure, and only such eggs as are obtainable without the use of force should be taken. After stripping the female the milt is expressed on the eggs by a similar manipulation of the male fish. To insure the contact of all eggs with the milt, they are gently stirred with the naked hand or by a careful movement of the pan.

The process of alternately stripping females and males is continued, with frequent stirring, until the pan is about half full, when the contents are carefully transferred to a transportation can or a keg, which has been previously half filled with water. In making the transfer do not subject the eggs to the drop incident to pouring, but lower the pan into the water before emptying. If this is impracticable, the same result may be accomplished with the dipper. As the eggs increase nearly 100 per cent in size shortly after fertilization, no more of the newly taken eggs than will fill the keg one-quarter full should be placed therein. If more than this amount is placed in the keg, loss of eggs from suffocation will result, as the eggs attain the greater part of their increase in size during the water-hardening process. As the eggs at this time have a strong cohesive tendency, it is necessary to agitate them at frequent intervals by stirring gently with the hand.

As soon as all eggs available for the day have been taken those on hand should be washed. This is done by pouring off and renew-

ing the water in the keg or can until all milt and sediment is washed out and the water on the eggs is clear. After washing, the cans should be filled with water and the eggs carefully watched. If the eggs show any tendency toward cohesion, they must be thoroughly agitated by carefully stirring with the hand. This precaution is to be taken throughout the time the eggs are in the possession of the spawn taker, and the water in the cans must be changed at least once an hour. Eggs taken from fish that have been in the nets more than 24 hours are seldom good, though the fish apparently may be in good condition. Eggs from dead fish are of no value. When changing the water on the eggs, or during the washing process, do not pour water directly on them, but lower the dipper into the container before emptying or pour the water against its sides. The more carefully the operations outlined are performed the greater the percentage of fry that may be expected.

BUFFALO FISH, ATCHAFALAYA (LA.) SUBSTATION.

[C. F. CULLER, in Charge.]

With the active cooperation of the Louisiana Conservation Commission in the form of financial aid in the operating costs of the station, in furnishing boats and other transportation facilities for the distribution of the output, and in other assistance the station in Louisiana was opened in December for the propagation of the buffalo fish. It was found necessary to move the hatchery building from its original location on the Atchafalaya River near the railroad station of the same name, because erosion of the river bank had advanced to within 10 feet of the foundation posts. A site was selected at Pelba, La., some 1½ miles west of Atchafalaya, and the building and its equipment relocated on the new site in time for the incubation of the season's egg collections.

Active fish-cultural operations began on March 1, when the first eggs were taken. The water temperature at this time was 54° F. and was immediately followed by a period of comparatively cold weather with a continuation of the low-water temperature. The incubation period on this lot of eggs was 21 days in a mean temperature of 54° F., about twice the time required for incubation in a water temperature of 60° F. Spawning continued until April 3, and during that time 142,850,000 eggs were obtained. Some 29,850,000 of them were planted on the spawning grounds; the remainder produced 51,000,000 fry for distribution.

It seemed probable that the new location of the hatchery would afford a more satisfactory water supply, and during the early part of the season this belief was justified. Later, with flood conditions on the Ouachita River, the Atchafalaya River received a large volume of turbid and discolored water, which, as in the past, caused a severe mortality among the green eggs under incubation. It seems evident that satisfactory water for the incubation of the eggs collected in this section is not to be obtained from the Atchafalaya River, and as clear water is available at no great depth by means of artesian wells it may be advisable to resort to this means for obtaining suitable water for hatchery purposes. It has been observed each season also that the turbid flood waters of the Ouachita River invariably cause a withdrawal of all the spawning fish from the affected areas.

MARINE FISHES.

Three well-equipped stations, one located in Maine and two in Massachusetts, whose work is confined to the propagation of the sea fishes, are operated by the bureau. During the fiscal year 1922 such work was addressed to eight species, the aggregate output of which amounted to 3,204,678,000 fertilized eggs and fry. There is a tendency toward the belief that much of the work of past years in marine fish culture has been of little value; that the causes making for abundance or scarcity of the marine fishes in any region are quite remote from any line of fish culture and beyond the control of man. If this theory is sound, the work of the fish-culturist as addressed to the marine fishes becomes, indeed, of no value. However, when the present trend of marine fish culture toward the conservation of the eggs in fish caught for market is taken into consideration and when it is realized that the market fishery is vigorously prosecuted over areas in which the fish have congregated for the express purpose, apparently, of spawning, and that truly enromous numbers of eggs are thus annually destroyed, it is difficult to believe that the salvage of these eggs by artificial methods can be entirely barren of results or that it does not justify the comparatively small outlay of funds thus expended.

BOOTHBAY HARBOR (ME.) STATION.

[E. E. Hahn, Superintendent.]

The principal activities of this station were concerned with the propagation of the winter flounder. Because of the prevailing scarcity of pollock in the Gloucester field the usual transfers of eggs of that species to the Boothbay Harbor hatchery were omitted, and the diligent search made during the season for eggs of the cod, haddock, and alewife was without results. There appeared to be no run of spawning haddock or cod, and but very few boats were engaged in fishing operations at the time when spawning fish might be expected. The roe contained in the few alewives secured was hard, and from the observations made it is evident that the spawning grounds of this fish are at a considerable distance from Boothbay Harbor.

Owing to the presence of ice on the fishing grounds, fishing operations for brood winter flounder as a source of egg supply for the station were begun later than usual and the season closed correspondingly late. Fyke nets were set on February 24, but no fish were taken until March 1, these being obtained by the station steamer and crew from nets set in small coves in Casco Bay. By March 5 all available nets had been installed, being set at points between Casco Bay and West Penobscot Bay, in Linekins Bay, and in and about Seal Harbor. The station steamer was used to fish the nets at the more distant points, making trips thereto at regular intervals until the close of the season on May 3. From all points some 7,000 spawners were secured, brought to the station, and transferred to retaining tables in the hatchery. The fish ran much smaller in size than in former years, but no loss was sustained during the period of their confinement, and there was an excellent yield of eggs of the finest

quality. From the 988,533,000 eggs obtained 922,777,000 fry were hatched and distributed, the deposits being made in the localities from which the brood fish were derived.

In accordance with past custom an exhibit of local fishes and other marine animals was maintained in the hatching room throughout the summer months, and it proved to be a source of much interest to the numerous visitors.

GLOUCESTER (MASS.) STATION.

[C. G. Corliss, Superintendent.]

The work of the Gloucester (Mass.) station involved the pollock, the cod, the haddock, the winter flounder, and the pole flounder. The collection of pollock eggs, taken up on November 7 and continued until January 19, netted 507,270,000 eggs for incubation. Although there appeared to be a good body of fish on the inshore fishing grounds throughout the season, they were continually moving from place to place, necessitating frequent shifting of nets and resulting in smaller daily catches. This condition characterized the entire season's work and had a direct bearing on the decreased numbers of eggs obtained. The collection of cod eggs extended from December 7 to April 16, the largest collections, as usual, being obtained during March and April. Spawn takers from the station were engaged on boats fishing in Ipswich Bay and Massachusetts Bay, one spawn taker being sent to Plymouth, Mass., to investigate the reports of large numbers of eggs available from that point. The season's work again demonstrated the need of a serviceable boat for use in connection with the spring collection of cod and haddock eggs. Most seasons the fishing fleet is distributed over so wide an area that without a suitable boat it is not possible for the small number of spawn takers employed to cover more than a small portion of the field. The season's efforts netted 306,960,000 eggs, 124,060,000 of which were planted immediately after fertilization. The number incubated at the hatchery was further increased by the transfer of 30,070,000 eggs from the Woods Hole (Mass.) station.

The collections of haddock and winter flounder eggs were taken up in the usual manner and resulted in obtaining 542,110,000 haddock and 110,580,000 winter flounder eggs. Some 75,960,000 of the haddock eggs were deposited on the fishing grounds after fertilization. All of the eggs of the various species taken to the hatchery were incubated successfully and the fry deposited at suitable points from which the egg collections were obtained.

The work concerned with the pole flounder, undertaken for the first time near the close of the fiscal year 1921, was continued during the first 16 days of July, 1922, resulting in the collection of 5,090,000 eggs. An increase in the numbers of ripe fish taken in the fishery as the season advanced was expected, but no such increase was apparent up to the time the work closed. An examination of the ovaries of the fish taken on July 16 showed a wide variation in the development. Many of the fish had small undeveloped ovaries, and others, in smaller numbers, taken in the same place, contained ripe eggs. From the information obtained it seems evident that the spawning period is much protracted, but that the

main body of fish spawn in August and September in the vicinity of Gloucester, Mass. It appears also that the eggs of the pole flounder can not be successfully transported from the point of collection to the hatchery by the methods now in use in connection with the other species handled.

WOODS HOLE (MASS.) STATION.

[W. H. THOMAS, Superintendent.]

As a result of arrangements made with the fishermen in October, to furnish cod for a brood stock, consignments began arriving November 10, and shortly thereafter additional deliveries brought the total for the season up to 4,023. This was somewhat more than the work required, and it was really in excess of holding facilities, but the supply available varies from season to season, and as conditions in this respect can not be foreseen, it is necessary to accept the stock brought in to insure future cooperation in the work on the part of the fishermen. The first consignment of brood cod was transferred to the cistern in a sea-water temperature of 50° F. Experience has shown that the best results can not be expected from such transfers in a water temperature exceeding 45°, and in future an effort will be made to profit by such experience. In order to obviate the possibility of purchasing immature brood fish, all fishermen were especially requested not to take any cod for the station in the vicinity of the shore, and it was evident from their description of the places of capture that the fish were secured at points where spawning cod are known to congregate. As in past years, the females outnumbered the males, but this could not be remedied, owing to the necessity of accepting all deliveries. The average weight of the brood fish was 6½ pounds, somewhat in excess of the usual average. Despite the fact that the quality of the stock as a whole was first class and the egg collections large, the percentage of hatch was disappointing. This is accounted for by the partial failure of the automatic temperature control to operate, the temperature at times fluctuating between 35 and 40° F. instead of remaining constant at 38. Salt appeared to collect on the valve and check its operation.

Trouble was encountered also from an accumulation of air in the cod boxes. This was particularly noticeable just after the filter was cleaned, there being so much of it at times that circulation was stopped, killing the spawn. Under the new arrangement effected last year the water supply for the hatchery is now pumped from the harbor into two wood stave tanks of 8,000 and 10,000 gallons capacity. Until the temperature drops to 38° F. it flows by gravity from these tanks to the hatchery through 6-inch pipe, thence through connecting 4-inch pipes to 2-inch lines extended over each set of tables, and from there through ⅜-inch pet cocks and connecting rubber tubes to the hatching boxes on the tables, the overflow from the boxes passing into a drain and back into the harbor. After the temperature has reached 38° the water is passed through pipes to a heating tank in the boiler room and the direct supply to the hatchery practically stopped. The overflow from the hatching boxes is then run into the cod cistern. The overflow from the

cistern is conducted into the filter, thence to a reservoir, and from there is pumped back into the storage tanks. By this means the water is heated in passing from the tanks to the hatchery, and while in the reservoir it can be again heated, if necessary, by a coil of pipe through which is passed water from the exhaust steam used in heating the building. This arrangement effects a considerable saving in coal as compared with past years.

During the winter, collections of winter-flounder spawn were made as usual at Waquoit, Mass., and Wickford, R. I., and although the operations were not as productive as in some previous years the results were on the whole fairly satisfactory, this being made possible largely through the strenuous efforts of the employees engaged in the work. In the Waquoit field particularly the spawn takers are beset with many difficulties. Not infrequently ice 8 inches or more in thickness must be sawed through before the nets used in the capture of the brood fish can be set or examined. Even under milder weather conditions there are many hardships to undergo, making the work exceedingly difficult. Operations at Waquoit extended from January 12 to March 24, during which time 819,927,000 eggs were secured, or nearly 35,000,000 more than in the previous fiscal year. An employee detailed to the Wickford field throughout the month of March obtained 228,768,000 eggs. The weather conditions during this period were comparatively mild, but for some reason the catch of fish was light. In the Newport field the fish are taken in deep water, which is so cold that they do not spawn freely until it is too late in the season to make successful shipments of eggs to the Woods Hole hatchery. Owing to this fact only 123,783,000 eggs were taken, notwithstanding the considerable numbers of brood fish secured. Possibly the fish can be held in live cars at some point where the water is shallower and warmer, and it is intended to make some investigations along this line at the first opportunity. Egg collections of this species from all sources amounted to 1,212,916,000, of which 166,751,000 were planted in the eyed stage of development. The remainder were hatched, yielding 844,381,000 fry, the percentage of hatch being 82.7.

In an effort to secure eggs of the mackerel almost daily visits were made to the local traps throughout the month of June, and as a result 2,022,000 were collected. The eggs were of uniformly good quality, nearly 99 per cent producing fry. Eggs of the scup to the number of 3,425,000 were also taken. In the early history of the station a few eggs of this species were occassionally secured, but until this year none whatever have been obtained since 1911, when a collection of 634,000 was made. The present season's collection was four times larger than any ever previously made. The percentage of hatch was 73.1, and had it not been for one large lot that was practically a total loss a very large percentage of hatch would have resulted. The efforts put forth to secure eggs of the sea bass were not wholly fruitless, as 32,000 were taken and hatched and the fry distributed without apparent loss. The last previous collection of these eggs was in 1910, when 850,000 were taken.

To satisfy a demand for steelhead for stocking a fresh-water pond at Mashpee, Mass., 25,000 eggs of that species were received at the station during the spring from Birdsview, Wash. Although the

consignment contained only about 400 white eggs on arrival, a large number had a cloudy appearance, and these either died in the egg stage or the resulting fry succumbed soon after hatching. The fry were planted immediately after the absorption of the yolk sac, the output amounting to 20,000.

NOTE CONCERNING LOBSTER PROPAGATION.

In various parts of the New England States there appears to be a growing sentiment in favor of the resumption of lobster propagation. This valuable crustacean formerly came extensively under artificial propagation at the marine stations, and for a number of years it formed the most important part of the work of the Boothbay Harbor (Me.) station. The hatchery at this point is particularly well located and equipped for the purpose, and with the lobster pound at Pemaquid as an auxiliary the station is prepared to save, with their eggs, many thousands of the egg-bearing lobsters which, there is every reason to believe, are now annually finding their way to the market.

The abandonment of the work resulted from a combination of circumstances, the most important, perhaps, being the failure of the interests most directly concerned to cooperate with the bureau. During the fiscal year 1921 the bureau was petitioned by a considerable number of citizens to again take up lobster propagation at the Woods Hole (Mass.) station, and during the current year the same topic has been the subject of much correspondence with persons interested in the lobster fisheries of Maine. There appears to be a quite general feeling that the present State regulations are not successful in preventing large numbers of the egg-bearing lobsters from reaching the market.

ANADROMOUS FISHES OF ATLANTIC RIVERS.

The fish-cultural work concerned with the anadromous fishes of Atlantic coastal streams during the fiscal year 1922 shows very satisfactory results. Under this group are included the Atlantic salmon, the humpbacked salmon introduced on the Atlantic coast, the shad, the river herrings (*Pomolobus æstivalis* and *P. pseudoharengus*), and the striped bass, or rockfish. The increased output of shad and river herrings is particularly noteworthy.

SHAD, BRYANS POINT (MD.) SUBSTATION.

[L. G. Harron, Superintendent.]

This station was opened at the beginning of the yellow-perch spawning season on March 1 and was closed May 20, shortly after the shad had finished spawning. The activities in connection with the yellow-perch work are discussed in connection with the propagation of the fishes of the Great Lakes, on page 46. The weather throughout the early spring was uniformly cold and stormy, the mean water temperature for the first 25 days of March being as low as 44° F. Such a condition always favors a good run of shad to the spawning areas in the Potomac River, as it causes the main body of the run of fish to ascend the warmer waters of the main river chan-

nel, thus escaping the numerous pound nets set for their interception on the flats and shallows of Chesapeake Bay. On April 6 shad in plentiful numbers were observed on the natural spawning grounds in the vicinity of the station, their arrival being at least 20 days later than in the preceding year, when abnormally high water temperatures ruled throughout the month of March. On April 10, when the first shad in spawning condition was found, and for 12 days thereafter, the water temperature remained too low for the successful ripening of their eggs. Consequently, the egg collections during this period, amounting to 5,442,000, were small as compared with the same period in former years. However, on April 24 a decided improvement in water temperatures was noted, and during the remaining days of the month eggs arrived at the hatchery in large numbers, giving a total up to and including April 30 of 31,306,000, which is seldom exceeded for that month.

These few days in late April proved to be the height of the egg-collecting season, as the catch of fish began falling off rapidly soon after the beginning of May, and by the 12th of that month many of the fishermen had suspended their operations. Eggs ceased coming in very shortly thereafter, the last consignment being received May 15. Of the season's total, aggregating 47,478,000, one lot of 1,311,000 was sent to the bureau's central station at Washington, D. C., for aquarial display; the remainder were hatched, producing a normal percentage of healthy vigorous fry for return to the local spawning grounds of the Potomac and its adjacent tributaries.

The season also proved a very successful one for the shad fishermen. They made unusually heavy captures throughout practically the whole of April, and though the prices obtained for their product were not as high as had prevailed during the preceding five years, their financial returns were greater.

SHAD AND RIVER HERRINGS, EDENTON (N. C.) STATION.

[DELL BROWN, Superintendent.]

There is also to be recorded a satisfactory increase in the output of shad in North Carolina waters. The spawning season at Edenton extended from March 28 to May 8, during which time 35,201,000 ripe eggs were obtained for incubation. More than 78 per cent of these produced fry at a cost of about $69 per million.

Because of the poor quality of the eggs obtained from fish taken in pound nets in this section, all shad eggs during the past season were taken from fish caught in gill nets, the fishermen operating on areas from which such apparatus is normally excluded by law. During the shad-spawning season licenses countersigned by the bureau's agent were issued by the State authorities to certain fishermen permitting them to use gill nets on the restricted areas, provided that all ripe eggs thus obtained were delivered to the Edenton hatchery. It is apparent that the prevailing sentiment of the region is opposed to this method of securing shad eggs, and many of the local citizens are of the opinion that greater results would accrue were the gill-net fishermen excluded entirely from the restricted area and the shad allowed to spawn naturally, basing their argument on the ground that only a small percentage of the fish taken by the gill nets contain ripe eggs.

Coincident with the spawning season of the shad in Albemarle Sound is that of the river herrings, two species, the branch herring (*Pomolobus pseudoharengus*) and the glut herring (*P. æstivalis*), coming under artificial propagation at the Edenton hatchery. Although less abundant, the branch herring, because of its larger size and early run, is more highly prized than the glut herring, though large numbers of the latter species are absorbed by the local markets.

From observations made of the spawning habits of these fish at Edenton during the past three seasons it appears that the branch herring spawn in about the same temperature as the shad, 62° F., but that the spawning of the glut herring is delayed until the water reaches a temperature of 66° F. The eggs of both species when first taken have a strong adhesive tendency. To overcome this in artificial propagation, they are passed through a fine screen immediately after being delivered at the hatchery. The incubation of branch-herring eggs is about five days, with a mean water temperature of 62° F., while the incubation of glut-herring eggs is completed in 36 hours at the higher water temperature of 66° F. The aggregate egg collections of the two species for the fiscal year was 116,920,000. From this number of eggs 82,600,000 fry were produced, all of which were planted on the local spawning grounds. As compared with last year's output of river herring, 43,815,000, the figures for the present year seem large, but they do not represent the full possibilities in artificial propagation that are present in Albemarle Sound. Closer cooperation on the part of the market fishermen and funds for the maintenance of operations over a longer period of time would undoubtedly very materially increase the amount of valuable work that could be accomplished. Like most of the bureau's fish-cultural work in connection with the commercial species, the herring eggs were all obtained from fish taken in pound nets by the local market fishermen.

The Edenton (N. C.) station, in addition to the work discussed above, produces annually a variety of the so-called pond fishes. This branch of the work is mentioned on page 77.

STRIPED BASS, WELDON (N. C.) SUBSTATION.

[DELL BROWN, Superintendent.]

An increase of fully 100 per cent is to be recorded in the amount of work accomplished with the striped bass at this station during the fiscal year 1922 as compared with the previous year. This may be attributed to the increased interest in the work on the part of the commercial fishermen, and if it is possible to maintain this spirit of cooperation among them it will enable the bureau to further extend its valuable line of work. The spawning season opened on April 12, somewhat earlier than usual, and egg collections were continued until May 15. This year's record output is in line with the increase in the output that has occurred almost without interruption since the inception of striped-bass propagation on the Roanoke River.

ATLANTIC AND HUMPBACKED SALMONS, CRAIG BROOK (ME.) STATION.

[J. D. DE ROCHER, Superintendent.]

During June of the fiscal year 1921 adult Atlantic salmon to the number of 208 were purchased from local fishermen operating weirs

in the Penobscot River and held in the Dead Brook inclosure pendin the development of their eggs, in accordance with the usual custo At spawning time, in late October, the 190 fish of this lot remainin yielded 572,000 eggs. This stock of eggs was increased through a other exchange with the Canadian Government, whereby the statio received 1,000,000 Atlantic-salmon eggs in return for an equal nun ber of eggs of the landlocked salmon, rainbow trout, and blac spotted trout, these being supplied from other stations of the bureau Both lots of Atlantic-salmon eggs were incubated with excellent r sults. The resulting fry to the number of 1,334,000 were deposite in Maine rivers, principally the Penobscot, and approximatel 100,000 fingerlings remained on hand at the end of the fiscal year.

During June, 1922, the attempts made to purchase adult salmon fo a source of egg supply for the coming year met with rather indi ferent results. The bureau's recently adopted policy of refusin longer to pay a so-called bonus of 60 cents per fish for carefu handling in addition to the market price, together with its decisio to reduce the average weight of the fish acquired, influenced most o the fishermen to sell their catch in the open market rather than t the bureau. Only three fishermen cooperated in obtaining the 5 brood fish secured.

The attitude of these fishermen is difficult to understand. Mos of them express themselves as being in accord with the work, an they readily concede that, because of the unnatural conditions no existing in the Penobscot, the run of salmon in the river is ap parently dependent on the output of the hatchery. They also recog nize that the salmon fishery has afforded them remunerative employ ment each season for many years. At the same time they are un willing to accept this form of business insurance without receivin extra compensation for the small amount of trouble involved i holding the fish for the bureau's agents, although it entails no mone tary loss from the sale of their fish and insures the salvage of a larg percentage of the prospective progeny and the ultimate release of th adult fish, for which they will receive the full market value.

The spring run of salmon in the Penobscot appeared to be light but reports were received, apparently from reliable sources, of the presence of large numbers in the Penobscot and Dennys River during August. It was stated by observers that the run of fish i both these streams was larger than for a long period of years. The run in the Dennys River is particularly noteworthy, since for many years this once important salmon stream has been quite barren o the species. Largely through the efforts of the bureau a fishway has been installed in the dam at Dennysville and, beginning in 1917, the river has been stocked annually with salmon fingerlings hatched from eggs taken in the Penobscot River. Present conditions with reference to Atlantic-salmon propagation are not entirely satisfactory, and the meagerness of accurate information concerning many details of the matter suggests the desirability of a rather thorough canvass of the situation.

Fish-cultural operations in connection with the humpbacked salmon in Maine waters were undertaken in the fall of 1921 for the second time. During September and October employees of the Craig Brook station obtained from the Dennys River, at Dennysville, Me.,

445,000 eggs of this species, and later on approximately 369,000 fry resulting therefrom were returned to the river. It is probable that a considerably greater number of eggs might have been secured had the conditions in the Pembroke River been more favorable. During the entire spawning season the water stages in this stream were too low to permit of the ascent of fish. The continuance of this run of humpbacked salmon, transplanted from the Pacific coast in Maine rivers, is an interesting fact. It occurs only in alternate years, and an effort to establish an annual run would perhaps be a wise undertaking.

RESCUE OF STRANDED FOOD FISHES.

[C. F. Culler, in Charge.]

During the fiscal year 1922 the total results of the bureau's rescue operations amounted to 179,475,069 fish, all of them being of direct importance to the regions in which the work was done. In the prosecution of such work 13 crews operated on the upper Mississippi River, in territory contiguous to the Homer (Minn.) station, La Crosse, Wis., and Bellevue and Marquette, Iowa. One crew was engaged on the Illinois River in the vicinity of Meredosia, Ill., and a considerable amount of rescue work on the Mississippi River was directed from the Fairport Biological Laboratory, in connection with the propagation of the fresh-water mussel. The operations also included a comparatively small amount of rescue work in fields around the San Marcos (Tex.) station. The tabular statement on page 10, showing the results of the bureau's activities along this line, indicates clearly the species and the number of fish salvaged at each point and their final disposition. The work was done at an average cost of approximately 14 cents per thousand fish rescued.

Rescue work for the season was first undertaken on July 5, in the vicinity of Homer, Minn., and was prosecuted as actively as possible at all the points mentioned until the exhaustion of the available funds on October 29 compelled its early closing, notwithstanding the fact that a number of landlocked pools in the vicinity of Marquette, Iowa, remained untouched. The work was rendered unusually difficult in some respects because of the unusually low stage of the river and the hot, dry summer. Because of excessively high temperatures at certain points large numbers of fish were found dead in pools of an average depth of 10 inches. Even such species as carp and catfish, which are particularly resistant to these conditions, suffered heavy mortality. The high air and water temperatures also made difficult the transfer of rescued fish to the river or the holding stations, and the utmost care was required to accomplish such tranfers successfully. In one respect the low water stages were of direct advantage to the work. As the overflow was restricted to a considerable extent by the river not reaching its usual high mark during the spring rise, the ponds left by the receding waters were all more conveniently located with reference to the river than is the case in seasons of a wider overflow. On the Mississippi one crew with houseboat operated from Prescott, Wis., to the head of Lake Pepin, thence to Brownsville, Minn., and Genoa, Wis.; one crew with houseboat covered the territory from Wabasha, to Fountain City, and

thence to Dakota, all in Minnesota; two crews worked from Homer, Minn.; one each from La Crosse, Genoa, and Ferryville, Wis.; one from Marquette, Iowa; one with houseboat between Dubuque and Bellevue, Iowa; and one from Bellevue, Iowa.

The work at Meredosia, Ill., was discontinued on September 15, at which time steps were taken to abandon the station permanently. Such part of the property as could be used to advantage at other points was transferred, while the buildings and the equipment that could not be moved successfully or that had no value in connection with the work elsewhere were sold to the highest bidder by authority of the Secretary of Commerce. The work that could be accomplished profitably at this point was decreasing in amount from year to year, as the movements of the fishing crews were becoming more and more restricted by the establishment of duck-shooting preserves. Large portions of this territory were also being reclaimed for agriculture.

FISHES OF MINOR INTERIOR WATERS.

In that part of its work relating to production and distribution of fish for stocking interior waters of the country the bureau solicits the participation of the public. It cooperates with interested individuals or associations in deciding as to the waters to be stocked and considers their suggestions as to the species of fish best suited therefor. It relies upon applicants to see that the fish furnished are properly planted in the waters for which they are assigned, and that they are afforded proper protection against illegal or unsportsmanlike methods of fishing. Although the species of fish involved are generally classed as game fish, they have important value, also, as food.

The benefits accruing from this phase of fish-cultural work are considered invaluable. Not only is there an economic gain in the increase of the food supply by the utilization of otherwise unproductive waters, but there is an educational effect that develops and fosters a sentiment favorable to the protection and growth of fish life. Moreover, innumerable persons derive direct and important benefits from a day's fishing in the open places.

While this part of the bureau's work has increased in volume with the development of its fish-cultural activities, it has not increased in the same proportion as has the work that is concerned with the commercial species, and whereas a few years ago the output of fishes for the interior waters represented from 8 to 10 per cent of the aggregate output, it now represents less than 1 per cent of such aggregate. The urgent need for an immediate expansion of this work is reiterated.

The numbers of fish and fish eggs produced and distributed for the replenishment of interior waters during the fiscal year 1922, including those diverted for this purpose from the rescue operations along the Mississippi River, were as follows:

Catfish	152,525
Landlocked salmon	398,010
Rainbow trout	7,228,225
Black-spotted trout	2,521,500
Loch Leven trout	56,000
Brook trout	9,991,855

Grayling	250,000
Crappie	42,352
Large-mouthed black bass	1,946,432
Small-mouthed black bass	645,808
Rock bass	46,258
Warmouth bass	2,515
Sunfish	141,172
Total	23,422,652

ROCKY MOUNTAIN TROUT STATIONS.

This group comprises the stations with their auxiliaries in the States of Montana, Colorado, Wyoming, South Dakota, and Utah. Their work is addressed to the trout indigenous to the region, to the brook trout and rainbow trout, which have been transplanted from other sections of the country, and to small numbers of the Loch Leven trout. The aggregate output of this group for the fiscal year 1922 was as follows:

Brook trout	4,818,435
Rainbow trout	3,324,840
Black-spotted trout	2,498,500
Loch Leven trout	36,000
Total	10,677,775

BOZEMAN (MONT.) STATION AND SUBSTATIONS.

[W. T. Thompson, Superintendent.]

Besides the main station at Bozeman there were two important auxiliaries, one on Meadow Creek in the Madison Valley, Mont., and the other in the Glacier National Park, operated in connection with the work of this field during the fiscal year 1922.

BOZEMAN (MONT.) STATION.

Fish-cultural work consisted in the propagation of brook, rainbow, and black-spotted trouts from eggs procured from brood stock maintained at the station, by transfer from field and other stations of the bureau, from the Montana Fish and Game Commission, and by purchase from commercial dealers. The percentage of hatch ranged from 70 to 99 per cent among the different lots, the latter percentage occurring among the black-spotted trout transferred from Yellowstone Park. During the summer and fall of 1921 about 1,500,000 fingerlings of all species were delivered to the bureau's cars for distribution to applicants throughout the States usually served by this station, and from the past season's hatch there was a similar number on hand for distribution during the summer and fall of 1922.

Of the brook-trout eggs handled at the station, 1,000,000, in round numbers, were supplied from the Springville (Utah) and Leadville (Colo.) stations of the bureau, 500,000 were purchased from a commercial dealer, and some 60,000 were taken from the station brood stock. The rainbow trout were all from eggs collected at the substation on Meadow Creek, while the black-spotted trout were from the Yellowstone National Park and from the Montana Fish and Game Commission. The number of eggs and fry received from the

latter source numbered upward of 1,500,000. To accommodate this extra assignment of valuable stock, it was necessary to provide additional hatchery space. This was accomplished by building an annex on the southeast side of the hatchery building, 50 by 20 feet in dimensions, equipped with 20 standard hatching troughs. In this connection appreciation is again expressed of the practical and liberal assistance rendered by the State of Montana in developing fish-cultural projects in which the bureau is particularly interested.

Of interest in connection with the distribution of fish from the Bozeman station during the year was the planting of brook trout in Kootenai River and Cameron Lakes, on the international boundary. The trip was not accomplished without difficulties, but none of them proved serious, and some 30,000 brook trout of the fingerling No. 1½ size, though four days en route, were successfully deposited in these waters. In making this trip the bureau received valuable assistance from the National Park Service and the Canadian Department of Marine and Fisheries, as well as from the Great Northern and the Northern Pacific Railroad Cos., who in each case furnished free transportation over its line. An opportunity was afforded the superintendent on his return from this trip to visit some of the lakes in the region with a view of ascertaining the possibilities for extending the fish-cultural work, and some interesting prospects were noted.

The State of Montana is devoting some effort toward developing a commercial fishery for the whitefish and lake trout in Flathead Lake. Working along this line the State collected whitefish eggs from St. Marys Lake, which were incubated at the Somers (Mont.) hatchery, and after making generous provision for parent waters the remaining fry were planted in Flathead Lake, together with additional fry from eggs furnished by the bureau from the Great Lakes.

MEADOW CREEK (MONT.) SUBSTATION.

Opportunity was afforded during the year to enlarge and improve the buildings at this important substation. The hatchery building, originally 18 by 24 feet, was enlarged to 24 by 38 feet, the additional space was equipped with troughs, and one room and porches were added to the cottage. Some 2,300 feet of wood stave pipe was also purchased and laid to connect the hatchery with Wilson Spring. The station and its equipment are now in good condition, and the advantages of the new water supply were evident in the improved condition of the eggs and fry handled.

The season's take of rainbow-trout eggs in Meadow Creek was below the average, due possibly to cold and otherwise unfavorable weather. Spawn taking commenced on April 24, about 10 days later than in a normal season, and ended June 8, fully a week earlier than usual. During this short period 1,800,000 eggs were secured. The usual shipments were made to the Montana Commission, to the bureau's stations and substations at Bozeman, Mont., Glacier National Park, and other points, and a reasonable number were reserved for incubation, with the view of replenishing local waters. Black-spotted trout obtained from the State of Montana and from the bureau's substation in the Yellowstone Park were also handled, the two lots yielding 425,000 fry of that species for distribution.

GLACIER NATIONAL PARK (MONT.) SUBSTATION.

The work of this small hatchery was addressed to the incubation of rainbow-trout eggs received from the Meadow Creek collections, black-spotted-trout eggs from the Yellowstone National Park and the State of Montana, and steelhead eggs from Applegate Creek, Oreg. The records indicate a distribution of 168,000 black-spotted trout, 250,000 rainbow trout, and 48,000 brook trout, with approximately 160,000 fingerling fish on hand at the end of the year. The bureau is indebted to the State of Montana for the brook-trout fingerlings appearing in the above record, and to this number may rightfully be added the 30,000 fingerlings of this species mentioned as having been placed in Kootenai River and Cameron Lakes.

In recent years the pelican has been much discussed in connection with the problem of fish culture and conservation in certain sections of the territory in this region, particularly as regards the Yellowstone National Park and the Madison Valley, in Montana. This bird, protected by law, it is claimed by many who are apparently in a position to know, constitutes one of the most important agencies in the destruction of the game fishes, and the evidence produced in support of this statement is of a convincing nature.

In order to obtain more authoritative knowledge on this important subject an investigator, working under the direction of the division of scientific inquiry, was employed near the close of the fiscal year to investigate the habits of the pelican in Yellowstone National Park.

LEADVILLE (COLO.) STATION AND SUBSTATION.

[C. B. Grater, Superintendent.]

LEADVILLE (COLO.) STATION.

During the year the rearing capacity of the Leadville station was increased by repairing and connecting with the water supply the 16 cement ponds in front of the hatchery building. Additional troughs were also placed in the hatchery.

The brook trout is the important species propagated at this station, and excellent results attended the efforts along this line during the fiscal year 1922. The eggs handled are obtained almost exclusively from privately owned lakes, where, under agreement with the owners, the bureau's fish-culturists annually make egg collections from spawning trout. The eggs thus obtained are all taken to the Leadville hatchery, where a predetermined percentage of the total collections from each point of eyed eggs, fry, or fingerling fish are held subject to the owner's disposal. During the fiscal year 1922 collections were made from seven Colorado lakes, as follows:

Turquoise	3,027,200
Engelbrecht	2,108,700
Carroll	235,500
Northfield	49,900
Fred Neal	176,000
Musgrove	587,600
Evergreen	96,500
Total	6,281,400

It is interesting to note that the collection obtained from Turquoise Lake was the largest ever made at that point. In addition to the brook-trout eggs obtained from this lake 37,000 eggs of the Loch Leven trout were secured. Transfers from other stations of the bureau to the Leadville hatchery included upward of 80,000 rainbow-trout eggs from Saratoga, Wyo., 200,000 black-spotted-trout eggs from the Yellowstone Park, and 50,000 lake-trout eggs from the Duluth station. The rainbow trout were used largely for stocking a lake in Jefferson County, Colo., where there are excellent prospects of developing a profitable field station, and 25,000 of the lake trout were delivered to an applicant in Pitkin County, Colo. The remainder of the fish entered into the general distribution in Colorado and New Mexico, or were included in the stock—some 2,500,000—remaining on hand at the close of the year.

YELLOWSTONE NATIONAL PARK (WYO.) SUBSTATION.

This station was operated during the year under the direction of the superintendent of the Leadville (Colo.) hatchery. The fish-cultural work, which involves a portion of two fiscal years, opened at Fish Lake, near Soda Butte, on June 8, and the collections of black-spotted-trout eggs at this point to the close of the year amounted to 263,500. Late in the season of the previous fiscal year and during the season of 1922 a building of log construction was put up for the bureau by employees of the National Park Service. As this building was not available for use during the spawning period, the eggs taken at Fish Lake were transferred to the Lake hatchery for incubation.

The spawning season of the black-spotted trout on Yellowstone Lake began on June 9, and the results of the season's efforts, both as to egg collections and the number of young fish returned to park waters, were the most satisfactory in a long period of years. The usual egg-collecting area was considerably augmented by extending it to streams not previously occupied along the South Arm of Yellowstone Lake, and, largely through the cooperation of officers of the park service, the unusually large output of fry and fingerling fish was disseminated over a much wider territory than ever before. Through the courtesy of the Montana Fish and Game Commission and by judicious exchanges of eggs, brook trout, rainbow trout, and grayling, as well as the native black-spotted trout, were available for distribution in suitable waters of the park.

SARATOGA (WYO.) STATION.

[O. N. Baldwin, Superintendent.]

A special appropriation provided by Congress and available July 1, 1922, permitted the erection of two cottages at the main station for the convenience and comfort of the statutory employees. These are of frame construction, with four rooms, bath, and cellar each. Funds were also available from the same appropriation for some development work at the field stations. It was therefore possible to erect a log building 28 by 36 feet equipped with 20 standard hatching troughs, and a cabin, also of logs, 20 by 26 feet, for the accommodation of the employees in charge. These buildings are

located on a tract of land near the confluence of the North Platte River and Lost Creek, in Carbon County, Wyo., adjacent to the Pathfinder Reservoir project of the United States Reclamation Service. In furnishing water for the hatchery a concrete dam across Lost Creek was necessary.

The distribution from the Saratoga station consisted of 298,500 brook trout, 924,740 rainbow trout, and 9,000 Loch Leven trout, with upward of 1,000,000 fish on hand at the close of the year.

Egg collections at the main station were confined to 130,000 brook-trout eggs and a small number of Loch Leven trout eggs from the brood stock. The rainbow trout at the field stations gave promise of being unusually successful. Racks for the capture of spawning fish were in place in Sage Creek, Canon Creek, and Lost Creek well in advance of the spawning season, and good numbers of fish were present in each stream. On May 10 a blizzard of intense violence, continuing for five days, visited this section, making all movement abroad impossible. The storm was followed immediately by mild weather, and the floods resulting from the rapid melting of the quantities of snow rendered fishing impracticable for a further period. With the abatement of the storm and flood the larger part of the fish had passed upstream. Eggs to the number of 1,355,800 were obtained, however. Reserving a liberal number to be incubated at the Lost Creek hatchery for the replenishment of the local streams, the remaining number were divided between the State of Wyoming and the bureau, the bureau's eggs being forwarded to the Saratoga station.

SPEARFISH (S. DAK.) STATION.

[D. C. Booth, Superintendent.]

Efforts at this station are confined to the propagation of the brook, rainbow, and Loch Leven trouts. Nearly 600,000 eggs of all species were produced from the station brood stock, and about 350,000 brook and rainbow trout eggs were transferred from other stations of the bureau. The percentage of hatch ranged from 52 to 74, and all but about 10,000 of the young fish were distributed throughout the territory ordinarily served.

Impelled by the difficulties annually experienced in obtaining satisfactory supplies of brook-trout eggs from outside sources, the station has recently been engaged in the production of a brood stock of this species. As a result there were on hand at the beginning of the fiscal year brood fish of excellent quality in adequate numbers to furnish sufficient eggs for the season's work. Before spawning time arrived, however, a large number of them had disappeared, and there is reason to believe they were stolen, though a night watch had been maintained during most of the year. As a consequence of the greatly reduced egg collections, a small number of eggs were taken from the few wild trout obtainable in neighboring streams, and 305,000 were shipped from the Springville (Utah) station. The total supply from these three sources aggregated 738,400, from which 301,500 fingerling fish were distributed, and a smaller number remained on hand at the close of the year.

From 66,150 Loch Leven trout eggs taken from station brood stock 27,000 fingerling fish were produced and distributed. This species, which is highly regarded by local fishermen on account of its game qualities, appears to outnumber any other trout in the Black Hills region, though the bureau's distributions of it have been small as compared with those of the brook and black-spotted trouts. This is probably attributable to the more vigorous nature of the Loch Leven and its ability to withstand conditions that tend to result disastrously to other species. During May and June the station distributed approximately 59,000 rainbow-trout fingerlings, derived from eggs secured from domesticated stock at the station, and early in June a shipment of about 53,000 eggs of this species was received from the Saratoga station. The eggs were in first-class condition on arrival, and the subsequent losses of eggs and fry were merely nominal. Owing to their excellent quality it is the intention to reserve a few thousand of these young fish to be reared for a brood stock.

SPRINGVILLE (UTAH) STATION.

[CLAUDIUS WALLICH, Superintendent.]

Fish-cultural work at this station proceeded along the usual lines, and the aggregate output of the various species handled during the year shows a satisfactory increase over that of the previous year. Brook-trout eggs were obtained from the collecting station on Twin Creeks, a tributary of Fish Lake, which field for a number of years past has been operated jointly by the bureau and the State of Utah. Eggs to the number of 7,250,000 were obtained during the spawning season, extending from October 23 to the end of November, and the collections were divided equally between the interested parties. There has been a steady and very gratifying increase in the numbers of spawning brook trout in evidence in all the spawning areas of Fish Lake, together with a corresponding increase in the egg collections each season. During the season of 1922 the largest number of eggs ever taken from the lakes were all obtained from spawning areas in Twin Creeks, and no attempt was made to work the numerous spawning beds on the west and south sides of the lake, where spawning fish were unusually numerous. This improved run of fish is attributed to systematic plantings of 3 and 4 inch fingerlings in the lake every year since fish culture was first undertaken in this region. The experience gained through a number of years having clearly indicated that no satisfactory results could be expected through the maintenance of a brood stock of brook trout, all of the brood fish of that species on hand at the Springville station were liberated during the year in open waters of the State. The results already accomplished at the field station devoted to this species show that efforts in brook-trout propagation can be more profitably applied in this direction.

About 482,000 eggs were obtained from the brood stock of rainbow trout. This species produces much more satisfactory results under domestication at the Springville station than does the brook trout. As funds were not available for maintaining a field force for collecting rainbow-trout eggs, an agreement was effected with the State Commissioner of Fish and Game for delivery to the bureau

of a limited number of eggs at the nominal cost of 3 cents per thousand f. o. b. the State hatchery at either Richfield or Sigurd, Utah. As an outcome of this arrangement 1,647,000 green eggs were secured. The policy of stocking the Kyune Reservoir liberally each year with rainbow trout and brook trout was continued, and prospects are encouraging for early results in the way of egg collections from this body of water.

The results from the brood stock of native black-spotted trout were disappointing in the extreme, only 23,000 eggs being taken from the 240 three-year old female fish in the station ponds, and these proved of inferior quality. No satisfactory explanation of this failure is at hand, except that it seems to coincide with the results of past efforts to domesticate this species of trout at other stations of the bureau. All of the brood fish appeared to be constantly healthy. They have made a satisfactory growth, and no excessive mortality has been observed. Nevertheless, but few of the fish showed signs of fecundity at the spawning season. This station is now holding in ponds in an experimental way a small number of the common catfish obtained from the Mississippi River.

The rearing capacity of the station was increased during the year by the construction of four ponds, each 4 by 50 feet in dimensions, with natural earth sides and bottoms, supplied with water from the hatchery overflow. A further improvement to the pond system was effected by diverting surplus water from the Strawberry irrigation canal. This water is always turbid, and it has been a source of great annoyance, not only at the bureau's station, but at the State hatchery and to local agriculturists. By the cooperation of all interested parties a considerable amount of work has been accomplished toward the construction of ditches and flumes to divert this waste water to the dam, and a marked improvement has resulted.

NEW ENGLAND TROUT AND SALMON STATIONS.

This group includes the five stations and their substations located in the States of Maine, New Hampshire, Vermont, and Massachusetts, whose work is concerned principally with the brook and rainbow trouts and the landlocked salmon, though small numbers of such species as yellow perch, pike perch, smelt, and small-mouthed black bass also appear in their outputs.

BERKSHIRE (MASS.) STATION.

[W. A. Casler, Superintendent.]

This station, situated in Berkshire County, Mass., near the village of Hartsville, was acquired under a deed of gift. At the time the property was taken over all buildings, walks, and ponds were in need of immediate repairs. Such repair work has been accomplished as rapidly as possible by devoting each year a portion of the very limited funds available for the operation of the station thereto. At the present time the buildings are all much improved, and the grounds have been maintained with reasonable care. The condition of the dams in many of the ponds is such that practical repairs can be accomplished only by a greater expenditure than is possible under the amount available for the maintenance of the station, and the

bureau has not felt warranted in asking Congress for special funds for this purpose in recent years.

The species of fish propagated at this station during the year included brook trout, rainbow trout, yellow perch, and pike perch. Brook-trout egg collections from the brood stock amounted to 260,000. The losses on these eggs during the incubation period, and again just prior to the absorption of the food sac, were so heavy that only 185,000 fry were produced and only 105,000 reached the fingerling stage and were distributed. The mortality is believed to have been largely due to the advanced age of the brood fish, which had been on hand for seven or eight years. With the view of remedying this defect, 500 fingerlings are now being reared at the station, and they will eventually replace the old brood stock. In addition to the brook-trout eggs collected, 88,900 eyed eggs were purchased from a commercial hatchery in Massachusetts, and from them a 98 percentage of fry was realized. All of these fish were distributed in waters in Massachusetts, Connecticut, and New York.

Fifty thousand eyed rainbow-trout eggs, transferred from the bureau's station at White Sulphur Springs, W. Va., were incubated with a 7 per cent loss, and 5,000 of this species collected from the station brood stock yielded a hatch of 43 per cent. As was the case with the brook trout, the advanced age of the parent fish was no doubt largely responsible for the inferior results, and on permission from the Washington office the brood rainbows were planted in Massachusetts waters.

Two hundred thousand yellow-perch eggs, transferred in an ordinary 10-gallon shipping can from the Swanton (Vt.) station, were incubated, and the fry were delivered to applicants in good condition. A further consignment of 3,300,000 eyed pike-perch eggs was transferred from the Swanton hatchery, and, though the station is not equipped for handling such eggs, 90 per cent of them produced fry, all of which were furnished to applicants.

CRAIG BROOK (ME.) STATION.

[J. D. De Rocher, Superintendent.]

That part of the fish-cultural work of this station addressed to the Atlantic salmon is discussed in connection with anadromous fishes of the Atlantic rivers on page 55.

During December, 1921, two consignments of eyed brook-trout eggs were received from commercial hatcheries, one in Maine and one in Massachusetts, and a third consignment was forwarded from Grand Lake Stream, Me., this comprising part of a shipment of eggs previously made to that point by the Pennsylvania Department of Fisheries. The eggs derived from the Massachusetts establishment produced a hatch of over 96 per cent and those from the Maine commercial hatchery of 91 per cent, while only 88 per cent of fry resulted from the Grand Lake Stream shipment.

From a consignment of 50,000 rainbow-trout eggs transferred from the White Sulphur Springs (W. Va.) station a hatch of about 93 per cent resulted. The output of the station was further augmented by the receipt of 70,000 eggs of the landlocked salmon from the Green Lake (Me.) station, which were incubated with a loss of about 4 per cent. All of the fry of the various species were distributed in New England waters, principally in Maine.

GREEN LAKE (ME.) STATION AND SUBSTATION.

[JOHN A. STORY, Superintendent.]

Operations in this field were confined to the work at the main station and the substation at Grand Lake Stream, Me., the collecting station at the Fish River Lakes being abandoned in favor of the Maine State Fish and Game Commission because of insufficient funds. The species handled involved the landlocked salmon, the brook trout, the smelt, and the small-mouthed black bass.

GREEN LAKE (ME.) STATION.

The work in connection with the landlocked salmon was taken up in October, when a pound net was placed in Green Lake for the capture of the spawning salmon. Fishing was continued from October 17 to November 12, and during the period 171 adult fish were taken. Of these 114 were females and 57 males, and 227,525 eggs were obtained. In addition 25,000 eggs were supplied the station from the State's hatchery at Oquossoc. Of the local collections 70,000 were shipped in the eyed stage for convenience in distributing fry and fingerlings to the various applicants in the State, and smaller numbers were supplied to applicants in other parts of the country. The remainder, with those received from the State, were incubated at the station for the replenishment of local waters.

Eyed brook-trout eggs to the number of 103,000 were acquired by purchase from commercial dealers, and an additional lot of 75,000 was received from the Pennsylvania Department of Fisheries and Game. The resulting fry were distributed in the waters of the State.

The efforts made to collect spawning smelt for propagation at this point were not successful. The cold rains occurring at spawning time apparently caused the fish to desert their customary spawning places in the tributary streams. An investigation of other ponds in the locality revealed similar conditions. The 300,000 eggs of this species obtained were incubated with but little loss.

Because of windy weather and the unusual depth of water in which nest-building occurred, but little was accomplished in obtaining small-mouthed bass fry from Green Lake waters. Some 22,000 were taken and supplied to applicants in other sections of the State. Fish of this species are not considered desirable in Green Lake, which is a natural habitat of the more highly prized landlocked salmon, and the removal of the bass fry for introduction into other more desirable waters meets with the approval of the local interests.

On the recommendation of the bureau the Green Lake station was closed as a permanent fish-cultural plant at the end of the fiscal year. It was estimated that not less than $25,000 would be required to replace the dam and water-supply flume, which were rapidly falling into decay, and in view of the fact that the water available at this site is of an inferior quality at best the discontinuance of the station seemed the only practical course to pursue. The bureau's property at Green Lake will be guarded by a custodian, and the more important items of fish-cultural work formerly prosecuted there will be continued as an auxiliary to the operations of the Craig Brook station.

GRAND LAKE STREAM (ME.) SUBSTATION.

A valuable addition to the rearing facilities at this substation was the acquisition, without cost to the bureau, through the courtesy of the St. Croix Paper Co., of control of the canal formerly used for the passage of boats over the quick water of Grand Lake Stream. Two ponds, each approximately 100 feet long by 25 feet wide by 3 feet deep, were constructed in this canal and proved entirely satisfactory for the purpose intended. Sliding gates at the point where the canal leaves Grand Lake control the flow of water through the ponds, and at slight cost additional ponds may be added to the present system.

At the beginning of the fiscal year there were on hand some 74,000 landlocked-salmon fingerlings, which were distributed in local waters during the summer months. The fall fishing operations resulted in the capture of 451 adult landlocked salmon, 192 females and 259 males. These fish averaged about 2½ pounds in weight, and approximately 252,000 eggs were obtained from them. One hundred thousand of these were shipped to St. John, New Brunswick, on behalf of the Canadian fishery authorities. The State of Maine furnished the station with 25,000 eggs of the same species from its hatchery at Oquossoc, and these, with the remainder from the local collections, produced fish for the restocking of local waters, about 100,000 fingerlings remaining on hand at the end of the year. During the spawning season unusually low water stages prevailed in both Dobis and Grand lakes. This condition was probably a factor in the reduced numbers of eggs taken, but it hardly explains the remarkably low average weight of the spawning fish handled.

The long-talked-of screen at the outlet of Grand Lake was completed during the year, the work being efficiently accomplished under the auspices of the Commissioner of Inland Fisheries and Game of the State of Maine. It will be of interest to note the effects of this installation on the salmon fishing of the waters involved.

In connection with the collection of landlocked salmon, a small number of brook-trout eggs was also taken, and 150,000 eyed eggs of this species were obtained from the State of Pennsylvania. Five thousand eggs of the local collections were delivered to a Massachusetts applicant; all of those remaining were incubated for local waters. In distributing the output the bureau is indebted to the local guides and boat owners who willingly carry the fingerlings to all of the important planting grounds, even the most remote, without expense.

ST. JOHNSBURY (VT.) STATION AND SUBSTATIONS.

[A. H. Dinsmore, Superintendent.]

Under this heading are included the main hatchery at St. Johnsbury, Vt., the substations at Holden and Swanton, Vt., and York Pond, N. H., and various egg-collecting points in Vermont and Maine. The work of the Swanton (Vt.) substations is outlined in connection with the propagation of the Great Lakes fishes on page 46.

ST. JOHNSBURY (VT.) STATION.

Five species of fish were propagated at this point, the brook, rainbow, brown, and lake trouts, and the steelhead salmon, the results being generally satisfactory. During the summer arrangements were made to collect brook-trout eggs on the Margalloway River and Parmancheence Lake in Oxford County, Me. As a preliminary to egg-collecting operations in this field a very satisfactory number of brood trout were captured and penned. Just at the approach of the spawning season there was evidence of malicious interference, which resulted in the liberation of the greater part of them. This being the third season's work in this region without any previous molestation no precautions had been taken to prevent such an occurrence. From the remaining fish only about 200,000 eggs were secured, half of which, by agreement, were turned over to the Guides Association after being eyed. The bureau's share of the fry hatched was released in adjacent waters with the exception of a lot of 10,000, which were reserved for rearing at York Pond. On account of the high quality of the eggs obtained and the rapid growth of the fry produced it is a matter of regret that the bureau's experience of the past three years has demonstrated the uncertainty of success in this field.

In order that all efforts might be concentrated on the work at York Pond and on the Margalloway River, it was decided to discontinue operations at Darling Pond and Lake Mitchell, in Vermont, but the owners of these waters were so urgent in their desire that the bureau continue its management of the work that it was finally agreed for them to assume the expense of operations and receive as compensation two-thirds of the fry produced from the egg collections at those points. The outcome of this arrangement was that the bureau secured about 290,000 eggs without incurring any expense in connection therewith. In addition to the collections referred to above 756,368 eyed eggs were purchased from a commercial establishment in Massachusetts, and 300,000 were transferred from the Pennsylvania Department of Fisheries and Game. For convenience in distributing the fry and fingerlings about 500,000 of the brook-trout eggs acquired were sent to the Holden substation. Besides the brook trout handled on behalf of the bureau some 40,000, the property of the Percy Sumner Club, were incubated for stocking Lake Christine, in New Hampshire. A consignment of brown-trout eggs were secured from the New York Conservation Commission, a portion of which were delivered to the State's hatchery at Roxbury, Vt., and 70,000 lake-trout eggs from the collections at Lake Dunmore were received from the Holden substation. Twenty-five thousand eggs of the steelhead obtained by employees of the State of Vermont in Caspian Lake were incubated at the station, the fry resulting being held at the disposal of the State.

Bass propagation at this station can not be termed successful so far as numbers are concerned, but quality has to some extent compensated for quantity, many of the bass distributed having attained a length of 4 to 6 inches. On account of the meager returns and insufficient funds nothing was attempted along this line during 1922.

Besides the usual distribution to applicants, liberal assignments of trout fry are made each year from this station for stocking

streams in the White Mountain National Forest. Such plants are carefully handled under the direction of the forest supervisor. The steelheads, the brown trout, and a small number of brook trout remained on hand at the close of the year.

HOLDEN (VT.) SUBSTATION.

At the beginning of the year there were on hand upward of 100,000 fingerling fish of various species that entered into the distribution of the fiscal year 1922. The substation was supplied with about 500,000 brook-trout eggs from the St. Johnsbury station. As customary, cooperative work with the State of Vermont addressed to the lake trout was undertaken at Lake Dunmore, resulting in the collection of 323,000 eggs, which, together with 25,000 of the same species shipped from Charlevoix, Mich., were incubated at the station. Fish-cultural work at Lake Dunmore is showing very gratifying returns. Each season a larger number of spawning fish are available.

The fish-cultural work at this substation during the fiscal year 1922 was unusually successful. All eggs handled produced a high percentage of fry, and the mortality among all species during the feeding period was light. In many seasons the mortality among both eggs and fry held in the spring water has been high, and this has been the subject of a number of investigations seeking the cause and the remedial measures that should be applied. During 1921 a new system of aeration was installed, which may have been an important factor in the excellent results obtained during the fiscal year 1922.

YORK POND (N. H.) SUBSTATION.

Actual fish-cultural operations at this point have been confined to the rearing of fry transferred from St. Johnsbury, Vt., some experiments in hatching brook-trout eggs in gravel, and the feeding of the adult fish in the pond. The work accomplished toward the development of the site for its ultimate object with the small amount of funds available is gratifying and reflects credit on the superintendent in charge of the work and his subordinates. The more important structures completed during the year are the cement dam diverting the water of Cold Brook to York Pond and a ditch carrying this water across the crest of an intervening ridge. From the ridge the water finds its way across a bottom of about 4 acres into York Pond. Eventually this 4-acre bottom will be converted into additional pond space. A control dam, also of cement, at the outlet of York Pond permits control of the water level of the pond, and one of the spillways in this dam has been continued to form a pit for a Poncelet wheel, which will furnish power for a fish-food chopper, dynamo, and possibly a wood saw.

During the winter after the work ceased a caretaker left in charge of the property cleaned the underbrush from the margins of York Pond, "slashed" two bottoms, which, with the completion of the plans, will be flowed, and completed much other work of a similar nature. In the course of the construction work a number of springs have been uncovered. The flow from these when concentrated will

furnish in connection with the flow from the pond a water supply of ample volume and, within reasonable limits, under control as to temperature throughout the year. It is expected that during the coming year the site will be sufficiently developed to permit of egg collections being undertaken successfully.

NASHUA (N. H.) STATION.

[Waldo F. Hubbard, Superintendent.]

The year's distribution of fish from this station amounted in the aggregate to 2,008,030 of the following species: Brook trout, rainbow trout, lake trout, landlocked salmon, small-mouthed black bass, yellow perch, and pike perch. With the exception of some 10,000 rainbow-trout eggs and 125,000 brook-trout eggs, which were obtained from the small number of brood fish maintained at the station, and the small-mouthed black bass resulting from natural spawning in Sunapee Lake, all of the fish distributed were produced from eggs purchased from commercial fish-culturists or transferred from other stations. The pike perch and yellow perch were received from the Vermont station on Lake Champlain, the lake trout from Holden, Vt., the landlocked salmon from Green Lake, Me., and the rainbow trout from Wytheville, Va. The brook-trout eggs were purchased from commercial fish-culturists in the New England States. There were no unusual circumstances attending the incubation of the eggs or the distribution of the resulting fish.

In discussing the affairs of this station it is considered proper to mention the deplorable condition of the bureau's property. The hatchery building—a temporary structure, built with no view of permanency—is at present a very dilapidated affair. The rearing ponds, which were originally constructed with plank sides, are in a similar state of decay and are of no value to the station. If the station is to continue its usefulness, funds for rather extensive repairs must be provided at an early date.

COMBINATION TROUT AND POND FISH-CULTURAL STATIONS.

The five stations in this group produced for distribution during the year 5,447,922 eggs, fry, and fingerling fish, as compared with 4,654,835 in 1921. The aggregate output by species for each of the two years is indicated in the following table:

Species.	Output.		Species.	Output.	
	1922	1921		1922	1921
Brook trout	1,685,100	1,664,950	Sunfish	125,945	62,355
Rainbow trout	3,402,487	2,583,244	Crappie	4,290	14,332
Small-mouthed black bass	43,383	112,591			
Large-mouthed black bass	147,774	121,978	Total	5,447,922	4,654,835
Rock bass	38,943	95,385			

These figures represent such species of fish as are actually produced at the stations and do not include fishes produced from eggs transferred from other points. The inclusion of such species would

increase the aggregate for 1922 by 4,960,000, which includes 4,900,000 yellow perch and 60,000 pike perch distributed, and for 1921 by 500,058, representing 500,000 pike perch and 58 yellow perch distributed.

ERWIN (TENN.) STATION.

[A. W. KEESECKER, Superintendent.]

During the year a number of improvements were made in the water supply and drainage systems and in certain of the ponds. Among the more important items accomplished were the installation of a new water-supply line, replacing the line in use for many years; the construction of a retaining reservoir in the spring branch from which water is now conducted to increase the flow in the stock ponds; a retaining wall around the main spring, protecting it from surface drainage; and certain changes and improvements to pond outlets.

Six species of fish came under artificial propagation at this station during the year, namely, the rainbow trout, brook trout, large-mouthed black bass, small-mouthed black bass, rock bass, and sunfish. In addition to those enumerated a small number of adult catfish transferred from the Bullochville (Ga.) station were on hand but were entirely nonproductive.

The spawning period of the rainbow trout extended from October 27 to January 10, the brood stock of about 1,600 female fish producing, in round numbers, 1,250,000 eggs. Of the number retained at the station 89 per cent produced healthy fry. The brook trout appearing in the distribution records were the result of eyed eggs acquired by purchase from commercial trout breeders in the New England States. Heavy rains and other unfavorable weather conditions at the spawning time were important factors in curtailing the production of the pond fishes, and a decrease in their output is to be recorded.

The investigator from the division of scientific inquiry continued his studies and experiments in connection with the spawning of the rainbow trout mentioned in last season's report, and though certain points of interest and value are indicated, no definite conclusions have as yet been established. Experiments looking to the improvements in certain conditions affecting the fish held in the station ponds were also conducted. These experiments were along the line of attempting to change the chemical properties of the water by the addition of certain acids. The results, however, were negative.

MANCHESTER (IOWA) STATION.

[F. E. HARE, Superintendent.]

A successful season in fish culture at the Manchester (Iowa) station is to be recorded. The brood stock of all species remained in good health throughout the year, and there was a satisfactory increase in the numbers of fish produced for distribution, the increases being especially noticeable with the rainbow and brook trouts.

The species handled were the rainbow trout, brook trout, steelhead, small-mouthed black bass, rock bass, sunfish, and pike perch, with

an aggregate output of approximately 1,000,000, and considerable numbers of fish remaining on hand at the end of the year to augment the brood stock or for later distribution. The brood stock of rainbow trout consisted of 1,900 adult females, some 900 of which were 2 years old. These fish yielded 512,000 eggs, and from those eggs retained at the station 95 per cent produced fry.

The brook-trout brood stock contained in round numbers 1,400 females, 1,000 of which were yearlings. From these fish 145,000 eggs were taken, all of which were incubated with a loss of 6 per cent. The output of this species was increased by the purchase of some 700,000 eyed eggs from commercial breeders. Steelhead eggs to the number of 25,000 were received from the Birdsview (Wash.) station and incubated without undue loss; the resulting fry will be retained for brood stock.

Weather conditions were unfavorable during the spring spawning season of the pond fishes, and none of them produced as prolifically as might otherwise have been expected. Successful results were obtained from the rock bass, 72 mature breeders of this species producing 16,650 fry and fingerlings for distribution. Pike-perch eggs to the number of 75,000 were received from the Lake Erie station, from which 60,000 fry were produced.

Two concrete ponds, each 21 feet wide by 32 feet long, and 2½ feet deep, with concrete sides, were made by combining three of the original nursery ponds into one of these. A portion of the bottoms was left in earth to induce the growth of pond vegetation. Each pond is supplied by three 1½-inch pipes, and they will be used for holding the brood stock when necessary, as well as for the accommodation of fingerlings at other times. Cement kettles were constructed in five of the breeding ponds, and all ponds at the station are now equipped with such kettles.

NEOSHO (MO.) STATION.

[FRED J. FOSTER, Superintendent.]

The station's output of rainbow trout was 57 per cent in excess of that of any previous year, notwithstanding the continued presence of a persistent parasitic affection among the older adults, making it almost impossible to secure good eggs from fish over 3 years of age. During the spring of 1922 an epidemic of "fluke parasites" attacked the fins and gills of the fingerling fish, resulting in some losses. This is the first authentic record of the appearance of the disease here, though from evidence at hand it is believed to have existed to some extent a number of years ago. After experimenting with several remedies, including potassium permanganate, the trouble was finally overcome through the application of a 1 to 15 solution of pure cider vinegar and water. The rainbow trout appears to be finely adapted to the waters of Missouri and the adjacent region, and frequent reports of excellent captures are received, many of the fish taken weighing from 4 to 8 pounds.

In order to determine the possibilities of brook-trout propagation at this station, a consignment of fingerlings and yearlings of that species was received for a brood stock from the Manchester (Iowa) station late in the year. On arrival the fish were found to be

thoroughly affected with gill trouble, a condition that is troublesome at Manchester. The effect of the change to this station will be carefully noted, and if it develops later that brook trout can be successfully grown here a brood stock will be built up and maintained as a source of egg supply for other stations of the bureau.

A recent investigation of the brood pond fishes by the bureau's pathologist conclusively demonstrated a fact that has been evident for some time, namely, that these fishes as well as the trout are affected with a cystic degeneration of the ovaries, and to this unhealthy state is no doubt attributable the greatly reduced output in recent years. Notwithstanding the presence of this disease the outcome of the year's operations with the pond species was successful to an unusual degree, over 100,000 fingerling fish being produced and distributed, and the black-bass production increased by 37 per cent over the output of the previous year. This favorable showing was made possible largely by the congenial weather prevailing during the spring spawning season, a condition that has been observed to occur on an average of once every eight years. During the spring a consignment of several million eggs of the yellow perch was received at Neosho from the bureau's Potomac River hatchery. Part of these eggs were turned over to the Missouri Fish and Game Department and the remainder were incubated, the loss in hatching amounting to 10 per cent. The efforts frequently made in the past to inaugurate yellow-perch propagation at this station have always resulted in failure, ovarian trouble making its appearance within the course of a year's time, with a consequent falling off in egg collections. As many of the waters in this region are adapted to the yellow perch, it is hoped that shipments of eggs of this species can be made annually from other hatcheries of the bureau.

WHITE SULPHUR SPRINGS (W. VA.) STATION.

[EDWARD M. HAYNES, Superintendent.]

The year's fish-cultural activities at this station were very generally successful, the aggregate output of the station being the largest in its history by more than 500,000 eggs, fry, and fingerling fish. Although the output of rainbow trout showed the most noticeable increase, there was also a larger production of the other species propagated. The brood stock of rainbow trout, of which 3,600 were females from 4 to 6 years old, yielded 2,210,000 eggs. Shipments of these to the number of 860,000 were made to applicants and to other stations of the bureau after reaching the eyed stage, and 80 per cent of the remainder produced healthy fry.

Because of the high mortality that occurs every year among the adult fish at spawning time only a comparatively small number of brood brook trout have been maintained at this station. The 700 three-year-old fish of this species on hand during the fall of 1921 yielded 115,000 eggs; 125,000 eggs from wild brook trout were received from the Springville (Utah) station; 450,000 were acquired by purchase; and the State of Pennsylvania furnished 300,000 in exchange for eggs of other species. The station also incubated 100,000 brook-trout eggs belonging to the State of West Virginia. Some 2,500 fingerlings resulting from the Utah eggs were retained at the station to be reared for a brood stock.

Because of the large demand for the pond fishes in this vicinity repeated efforts have been made to propagate the large-mouthed and small-mouthed black basses and other similar species. Climatic conditions appear to be the main barrier to success in such work. Frequent and sudden fluctuations in both air and water temperatures incident to the rather high elevation result each season in a very considerable loss of both eggs and young fish. During the fiscal year 1922 the results attained from the propagation of the so-called pond fishes were more successful than usual, though not altogether satisfactory. Seventy adult small-mouthed black bass produced 40,000 fry and fingerling fish. The large-mouthed black bass made a much better showing, the nesting of 23 brood fish resulting in approximately 66,000 small fish for distribution. The crappie failed entirely to reproduce, while 125 adult sunfish produced some 16,600 fingerlings. The brood stock of rock bass, 140 in number, appeared to be in excellent condition and a fair number of young were expected, but only 5,000 were available at the distribution period.

WYTHEVILLE (VA.) STATION.

[G. A. SEAGLE, Superintendent.]

During the extended spawning period—October 13 to March 31—732,500 rainbow-trout eggs were obtained from the brood stock, which consisted of 3,300 female fish, about one-third of the number being 2-year-old fish at their first spawning. Approximately 463,000 of the eggs were retained at the station for incubation, and 90 per cent of them produced fry; the remainder were shipped to various States and foreign governments and to other stations of the bureau. The brook trout distributed from this station were produced from 100,000 eggs that were acquired by purchase and incubated with but a nominal loss. In the early spring, however, the fingerlings suffered a heavy mortality, and but 53,000 were available for applicants.

The year's work with the pond fishes represents a fair average of the work of the past few seasons, although it is far from satisfactory, and it is hoped that certain changes instituted during the year in the water-supply system and drainage and along other lines will effect a material increase in the output for the next fiscal year. The more important improvements included a new settling tank and filter and the completion of the nursery building mentioned in the report for the fiscal year 1921.

After heavy rains the spring water at Wytheville becomes very turbid, owing to the seepage of surface water into the spring source. This water when coming at certain stages of development of the brook-trout fry causes serious losses, and during the spring of 1921 practically the entire stock of brook trout was lost. The effect on the rainbow trout has not been so serious. To overcome this difficulty of turbid water, a concrete settling tank was constructed, approximately 20 feet wide by 70 feet long, with a cement partition extending longitudinally through the center to a point near one end. This makes it necessary for the water to flow approximately 140 feet, after which it enters a sand filter having a surface area of 80 square feet.

An alum-dropping device was placed near the spring and a dosage of 1 grain of alum to each 2⅛ gallons of spring water was supplied to the settling tank. This rate of feed equals 1 part of alum to 124,000 parts of water, and since the untreated spring water entered the settling tank at the rate of 80 gallons per minute it required approximately 8 pounds of alum per 24 hours. The untreated spring water was so turbid that fingerling fish could not be seen in the troughs, but the treated water entered the hatchery as clear as crystal. The untreated spring water contains sufficient alkali in solution to react completely with the small amount of sulphate of alumina necessary to remove impurities, leaving sufficient alkaline nitrate to prevent any "aftercoagulation" in the filtered water. A practical test has been made of this system, and sufficient water was filtered to supply 350,000 fingerling trout No. 2. Since it clears the water, no matter how turbid, it is believed that brook trout can now be raised successfully at the station.

A device, believed to be unique, for cleaning the sand used as the filtering element was also tried out successfully. It consists of a spiked tooth rake, which may be drawn back and forth through the sand by means of a windlass sprocket wheel and chain. The flow of water in the sand bed of the filter is reversed during the cleaning process and is discharged into the waste ditch by opening a valve.

POND FISH-CULTURAL STATIONS.

The work of the remaining group of stations, seven in number, was concerned with the propagation of the so-called warm-water pond fishes. The aggregate output of such fishes from these stations during the year amounted to 2,702,480 fry and fingerlings, as compared with 2,473,711 in 1921 and 1,837,508 in 1920. Though the increases noted in the production of such fishes are of interest, indicating, to some extent at least, the application of improved fish-cultural methods as a result of the knowledge gained from past experience and from special investigations, such increases are by no means adequate to meet the pressing needs for a larger output of the species involved. For a long time the bureau has found it very difficult to honor requests for the pond fishes with promptness because of the limitations imposed by natural conditions on their culture. This difficulty has assumed larger proportions with the constantly increasing interest in fish culture and the increased demands for fish for stocking barren or newly formed bodies of water or for the restocking of such waters as have, for various reasons, become depleted of their indigenous fish life. At present all fish of this class that can be produced with the existing facilities are assigned from one to one and one-half years in advance, and it is only in rare instances that requests for the pond fishes can be honored during the fiscal year in which they are submitted. Some means for an increased output of the pond fishes continue to be an urgent requirement of the fish-cultural division.

COLD SPRINGS (GA.) STATION.

[CHARLES A. BULLOCK, Superintendent.]

The year's output from this station comprised 213,910 fry and fingerling fish, as follows: 118,185 large-mouthed black bass, 87,200

sunfish (bream), 8,200 catfish, and 325 crappie. The sunfish distributed were produced in Harris Pond and transferred to the Cold Springs station at intervals between August and October as they attained suitable size for handling. They were removed from the pond by means of a 100-foot seine of ¼-inch mesh, which was drawn slowly through the water in order to allow the smaller fish to escape through the mesh. The season's work with this species was the most successful ever experienced at the station, but the outcome of the work with the crappie was far from satisfactory. In the hope of improving conditions the brood stock of this species was transferred to another pond in the spring of 1922, and at the close of the year a considerable number of fingerling crappie were seen in this pond. The ouput of catfish was also derived from Harris Pond. These fish were secured in connection with the sunfish collections, and a sufficient number were obtained to fill all applications on hand.

In an effort to check the increasing losses among the adult large-mouthed black bass, which have recently assumed alarming proportions, and with the view also of reducing the cost of their maintenance, the food supply of this species was changed at the beginning of the year, beef heart being substituted for fresh mullet, which has been the exclusive food for a long period of years. The change proved detrimental, as the mortality increased during the first five months of the year, and this heavy loss of brood stock resulted in a curtailed output of young bass. The loss of adult fish, externally appearing to be in prime condition, has been an unfavorable factor at this station for some time. The greatest mortality has heretofore occurred in August, but it was so heavy this year during the spring months that a resumption of the fresh mullet diet was resorted to with considerably reduced losses. It is presumed that the food of the adult bass was deficient in some element present in the natural food supply at the more successful stations, being apparently present in insufficient quantities in the fresh mullet and lacking to a still greater extent in the beef heart. This was probably the cause of the loss of fish. It is possible that the missing substance is phosphate of lime. This important element would undoubtedly be present in sufficient quantity in waters well stocked with suitable natural food for the fish, and it is proposed to conduct a control experiment by adding ground green bone to the beef heart. On account of the great demand for bass, the station force undertook to make collections during May in a large lake located near Birmingham, Ala., but the attempt was given up after securing only 12,000 fry as a result of 25 days' effort.

EDENTON (N. C.) STATION.

[Dell Brown, Superintendent.]

The more important work of this station—that addressed to the propagation of shad and river herring—is discussed on page 54. In addition to the output of such species the station produces and distributes every year a comparatively small output of large-mouthed black bass and sunfish. The ponds available for this work are not particularly well suited to it, being too shallow and of insufficient area for the best results, and although the pond-fish-cultural work is to some extent an incidental item in the affairs of the station even

the small numbers of such fish produced become of importance in view of the heavy demand for them as compared with the limited facilities for their propagation. The station's output of pond fishes for the fiscal year 1922 aggregated 50,675.

LOUISVILLE (KY.) STATION.

[C. W. BURNHAM, Superintendent.]

The aggregate output of this station for the year was in excess of 600,000 fry and fingerling fish of the following species: Large-mouthed black bass, small-mouthed black bass, rock bass, sunfish (bluegill), and yellow perch. Special attention has been given to the propagation of the small-mouthed black bass, and there has been a gradual increase in the output of that species for the past three years. During this fiscal year 345,000 advanced fry and fingerlings of this species were produced and distributed to applicants. It is of passing interest to note in connection with this work that 143 small-mouthed black bass adults from Lake Erie, which were placed in spawning ponds at the station just a few days before the mating season, produced 114,000 fry, although during the previous year adult fish from the same source were placed in the ponds in October and failed entirely to spawn. The brood stock of 100 large-mouthed black bass, though apparently in excellent condition, was practically nonproductive, only one school of fry being observed. This is probably attributable to the advanced age of the brood stock. The work concerned with the rock bass and the sunfish was successful to the extent that the numbers of those species produced compare favorably with the output of previous years. The stock of yellow perch, consisting of 315 small-sized adults, produced 50,000 fry, and because of the unsatisfactory returns from these fish over a period of several years, all of them were liberated in the Ohio River at the end of the spawning period. As the yellow perch appears to be a highly prized fish in the locality, 200,000 eggs of this species were transferred to the Louisville station from the Potomac River, and a satisfactory percentage of fry was obtained from them for distribution.

MAMMOTH SPRING (ARK.) STATION.

[W. S. VINCENT, Superintendent.]

The work of improving the station pond system, which has been in progress for the past two years, was carried forward as time permitted. Such work included remodeling of the standpipes, construction of kettles in some of the ponds, and the formation of one large pond by throwing four small ponds of the old system together. The extreme eastern section of the levee, which runs parallel to the creek, was strengthened by riprapping that portion that is most exposed to the ravages of drift during high-water periods; and, as a precaution, a ditch 1½ feet wide by 2 feet deep was cut in which to start the wall, thus insuring the new rock work against slipping. As the base of the new construction is from 8 to 10 feet wide and from 3 to 5 feet in width at the top, it is believed it will

withstand any freshet that is liable to occur in Warm Fork. From this point west for about 100 feet the levee was brought to grade, thus obviating all possibility of inundation of the station grounds during floods.

During the fall the brood stock of all species of fish handled at the station was augmented, partly through transfers of fish from northern points and partly through collections from local waters, such collections also including supplies of minnows as a source of food for the adult fish.

In order that they might be under close observation, the 100 small-mouthed black bass received from Lake Erie were placed on arrival in the smaller of the two ponds maintained for the culture of this species. In the course of the spawning season in the spring 12 nests of various sizes were noted in this pond, all being below the average except two. Each of these yielded 4,000 fry, while the fry proceeds from the 12 nests amounted to 12,000. In the larger pond, used for the spawning of the 200 older fish, 25 nests were occupied, and 49,600 advanced fry and fingerling fish were the net result. From observations made during the season it was ascertained that the eggs hatched in four days, in an average water temperature of 69¼° F. and that the maximum number of fry from a single nest was 6,000, the average for the entire number being 3,000. The spawning season began on April 5 and continued at irregular intervals to May 2.

From the spawning of the large-mouthed black bass, which commenced about two weeks later, nearly 39,000 advanced fry and fingerlings Nos. 1 to 3 were collected and distributed before the close of the year, and a considerable number of young bass were still in the pond on that date.

The outcome of the year's work with the rock bass is deemed noteworthy, over 15,000 fingerling fish No. 2 being seined late in the fall from the pond occupied during the previous spring by 60 brood fish of that species. After supplying about 4,000 of these fingerlings to applicants the remainder were stored for spring distribution in one of the newly constructed ponds. Unfortunately the water temperature in this pond was not under control, and before the fish could be collected for shipment in the spring they were subjected to unseasonably high temperatures, with a consequent loss of a large proportion. During April and May the nests of the rock bass were held under close observation to determine, if possible, the number of fry produced from a single nest. A fry container was used to confine the fish, which during the early stages were about three-sixteenths of an inch long. They were fed at frequent intervals on Daphnia. Just before the conclusion of the experiment, however, the cheesecloth walls of the retainers were wrecked by high winds, permitting all the fish to roam at large in the pond.

Close observation was kept on a brood stock of 75 crappie maintained during the year, but without securing any information as to the time or extent of their spawning. However, in the process of drawing down the bass pond adjoining the one containing the crappie, 54 young crappie were gathered from among the bass.

ORANGEBURG (S. C.) STATION.

[G. W. N. Brown, Superintendent.]

Though special efforts were put forth to increase the output of this station, resulting in an increased production of approximately 50,000 fish, principally large-mouthed black bass, the outcome of the season's work was disappointing.

After a particularly careful preparation of the spawning ponds the 436 large-mouthed black bass comprising the brood stock were installed therein early in February. As the breeding fish were in excellent condition, a large crop of young bass was confidently expected. The first spawning occurred in February, when a number of nests were occupied, but because of the prevailing high winds and the resulting turbidity of the water none of these nests produced fry. No further nesting was observed until the middle of March, but from that time until May 10 spawning was in progress at intermittent intervals, with the result that 257,786 young fish were available for distribution. High winds and rains were prevalent throughout the entire season, both influences reacting to the detriment of the work. A rainfall of 30.05 inches was recorded at the station between January 1 and June 30, 1922.

The outcome of the work addressed to sunfish propagation represents an average season, but in view of certain changes whereby an increased pond area was provided for this species a considerably increased production may reasonably be expected during 1923.

The crappie and the rock bass fail to thrive in artificial environment at Orangeburg. Both of these species refuse artificial foods and fail to avail themselves of such natural food as may be present in the water supply. As a consequence, they soon become emaciated and die. More satisfactory results are expected from the warmouth bass, with which two of the newly constructed ponds were stocked.

In addition to the fish-cultural work much was accomplished along the lines of improving ponds and other property. Among the more important items of this work may be mentioned the construction of new ponds, extensive repairs to pond embankments, and improvements to the surface-drainage system, with the view of protecting the ponds, roads, and grounds from surface drainage during periods of rain.

SAN MARCOS (TEX.) STATION.

[Mark Riley, Superintendent.]

The past year's work has been the most successful in the history of the station. The total output of all species amounted to over 700,000 fish, ranging in size from No. 1 to No. 8 fingerlings, over 500,000 being large-mouthed black bass. Southern Texas is a natural habitat of the black bass, and it is believed the conditions fully warrant an increase in the scope of bass propagation in this section of the State. Although all natural surroundings are favorable to bass production, the same can not be claimed with reference to the crappie. Repeated efforts have been made and various methods tried in the propagation of this fish, but all attempts along that line have

proved unsatisfactory. If work with the crappie is to be continued at this station, it is believed a pond should be prepared and set aside especially for that purpose. Under present arrangements a few thousand are collected annually from the ranchmen's stock-watering ponds and distributed to applicants, such ponds having been stocked by the bureau with the understanding that part of the young fish realized were to be utilized in its distribution work. Crappie seems to do well in these roily water ponds, but the existing arrangement is unsatisfactory to most of the ranchmen who are averse to giving up the fish after their ponds have become stocked. Moreover, many of these ponds evaporate during the summer months, and dependence can not be placed upon them for supplies of young fish for distribution.

The rock bass does not seem to thrive in this part of Texas. On several occasions in the past brood ponds stocked with this fish have been flooded, permitting many of the fish to escape into the San Marcos River, but as very few rock bass have ever been observed it is assumed that the species is not adapted to the region. Considerable work was accomplished during the year with the sunfish, and a sufficient number were produced to fill all applications, the output numbering about 86,000.

During the year an agreement was entered into with the State whereby it is expected to prevent duplication of effort in the distribution of fish. This agreement comprehended the division of the State for fish-cultural purposes into two nearly equal parts. All applications emanating from the northern section were to be honored from the State hatchery at Dallas, while the bureau's San Marcos hatchery was made responsible for requests from the southern section. Theoretically, at least, this arrangement tends to reduce distribution costs to both agencies concerned. Just what its practical results may be is at this time uncertain.

During the winter of 1922 an experiment was conducted to determine the possibility of hatching rainbow-trout eggs at the San Marcos station with a view of furnishing rainbow trout for Medina Lake, at San Antonio, and Comal Creek, at New Braunfels, Tex., both of these bodies of water having been represented to the bureau as being suited to the species. For this purpose 15,000 eyed eggs were forwarded from the Neosho (Mo.) station, arriving on January 26 in apparently good condition. Owing to a difference of approximately 35° in temperature between the eggs in the case and the hatchery water it took about 24 hours to temper the eggs. This was done with the utmost care. Two kinds of trays were employed in the hatching operations, about half the eggs being placed on trays of fine mesh and the remainder on trays covered with the ordinary oblong mesh. A considerable death rate prevailed among the eggs before hatching commenced on January 22, and it was observed that all fish hatched succumbed almost immediately, the entire consignment perishing either as eyed eggs or as fry. As it appeared impracticable to incubate the eggs successfully at the San Marcos station the requests for Medina Lake and Comal Creek were subsequently honored by making shipments of rainbow-trout fingerlings from one of the trout stations.

TUPELO (MISS.) STATION.

[David Davies, Superintendent.]

The fish distribution from this station during the year included the large-mouthed black bass, the sunfish, and the crappie. The aggregate output in round numbers amounted to 385,000, and approximately 600 requests from applicants in the States of Mississippi, Louisiana, Alabama, Arkansas, and Tennessee were honored, leaving an indeterminate number of fish remaining on hand at the close of the year.

As opportunity offered without interference with fish-cultural operations or without involving any additional expense, work was continued on the construction of the new pond, and about 290 feet of the south embankment was finished. This pond will have an area of 2.14 acres, and about 140 feet of additional embankment will be required to complete it.

CENTRAL STATION AND AQUARIUM, WASHINGTON, D. C.

[L. G. Harron, Superintendent.]

In an effort to maintain a display of fish life for the edification and information of the public, several difficulties were encountered in the course of the year that detracted considerably from the usual effectiveness and value of the exhibit. The rapid increase in the population of Washington during recent years, with the consequent increase in water consumption, has taxed the city's water conduits to the limit of their capacity. This condition led the President early in the fiscal year to direct all Government departments to curtail as far as practicable their use of water. In compliance with this order the bureau abandoned for the warm period of the year its display of the trouts, salmons, and grayling, all of which require a considerable flow of cool water, and confined its exhibit to the so-called warm-water fishes, the latter requiring only a comparatively small flow of water. Upward of 1,000 fish ranging in size from fingerlings No. 3 to adults were disposed of, the adults being turned over to the New York Aquarium and the smaller fishes planted in public waters. Further difficulty arose during the early spring when the health authorities found it necessary to use chlorine as a sterilizing agent in the city water supply, it being understood that this is the first time in the history of Washington that such a course has been necessary. The effects of this agent were immediately noticeable among the fish at Central Station. Within 48 hours after its introduction in the water all the eggs and fry on hand were dead, the loss amounting to more than 2,250,000. The adult fish were also affected, the trouts succumbing first, though such species as the sturgeon, the catfish, the black basses, and the crappie were lost also.

To demonstrate for the benefit of the visiting public the various methods and apparatus used in the incubation of fish eggs and the rearing of fry, efforts are made to keep eggs and fry of the various species propagated on exhibit at such times as is possible. The

aggregate number of fish eggs thus handled during the fiscal year 1922 was as follows:

Chinook salmon	11,100
Atlantic salmon	19,950
Brook trout	49,870
Rainbow trout	50,000
Lake trout	1,000,000
Whitefish	600,000
Shad	1,311,000
Total	3,041,920

Fry to the number of 2,300,500 were hatched from these eggs, but practically all of them were lost, as described above.

An interesting occurrence in connection with the aquarium fishes was the spawning of a pair of Potomac catfish. On the morning of June 12 it was noted that a pair of Potomac catfish (*Ameiurus catus*), which had been held in one of the small aquariums since April 29, had prepared a nest in the gravel covering the slate bottom of the tank, and the female had deposited therein a glutinous mass of eggs. The number was roughly estimated at 600, but this proved to be considerably below the actual number. The male fish immediately assumed charge of the nest, working over it constantly, agitating the water over the eggs with a quick gentle motion of the pectoral, ventral, and caudal fins. He maintained his vigil from the time the eggs were deposited until the fry were hatched and were strong enough to leave the nest. At no time did he permit the female to approach the nest. His labors were evidently for the purpose of keeping the eggs free of sediment and circulating the water through the mass. When first deposited, the eggs were of a pale-blue color. The incubation period was eight days in a mean water temperature of 75° F.

When the fry first emerged from the egg, they were about one-fourth inch in length, transparent, and of about the same color as the egg. They remained on the nest for the first six days, at the end of which time they began rising a few inches above it, at first falling back almost immediately, but gradually remaining longer above the bottom. By the eighth day they were strong swimmers and seemed about to scatter. On the ninth day they were transferred from the aquarium to a hatching trough, numbering at that time 1,453 by actual count. In the trough they received food (beef heart) twice a day, which they took readily. They made excellent growth. When nine days old, they averaged five-eighths of an inch in length and by the end of June, when 19 days old, 1 inch.

Part 2.—DISTRIBUTION OF FISH AND FISH EGGS.

[E. C. Fearnow, Superintendent of Fish Distribution.]

The total net output of the bureau's stations (see table, p. 8) for the fiscal year 1922 (5,125,101,320 fish and fish eggs) was widely distributed, shipments of fish and eggs being made throughout the States and to Alaska and Hawaii and assignments of eggs to Canada, Czechoslovakia, and Switzerland. About 99 per cent of the output was made up of fish and fish eggs of commercial species, which were planted in waters where the egg collections were made, except in

instances where the eggs were shipped to State fish commissions (see p. 88). In the list of commercial species are included fishes rescued from the landlocked sloughs along the Mississippi River (see p. 10).

The species propagated for the purpose of stocking interior waters are brook trout, rainbow trout, black-spotted trout, large-mouthed black bass, small-mouthed black bass, rock bass, sunfish, crappie, and catfish. The great economic value of this work is attested by the large number of favorable reports received from organizations and individuals concerning plants of fish made in waters, many of which contained no fish life prior to such introduction by the bureau (see discussion and tables on p. 111).

TABULAR SUMMARIES OF DISTRIBUTION.

DISTRIBUTION TO ALL APPLICANTS.

The following table shows in summarized form the numbers and species of fish and fish eggs of the net output of the hatcheries for the fiscal year 1922 that were delivered to applicants.

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922.

[Asterisk (*) denotes eggs; dagger (†), fry; all others are fingerlings or yearlings.]

UNITED STATES AND TERRITORIES.

State and species.	Number.
Alabama:	
Catfish	5,260
Large-mouthed black bass	†60,500
	80,169
Rock bass	2,500
Small-mouthed black bass	650
Sunfish	51,950
Alaska:	
Humpbacked salmon	210,000
Sockeye salmon	*150,000
	†28,400,000
	51,820,000
Arizona:	
Catfish	495
Crappie	178
Large-mouthed black bass	390
Rock bass	200
Sunfish	105
Arkansas:	
Crappie	725
Large-mouthed black bass	†14,000
	32,870
Rainbow trout	28,025
Rock bass	4,042
Small-mouthed black bass	†63,000
	1,000
Sunfish	21,900
Yellow perch	†300,000
California:	
Catfish	960
Chinook salmon	5,872,200
Colorado:	
Black-spotted trout	349,000
Brook trout	†471,000
	2,437,550
Catfish	2,225
Crappie	50
Lake trout	25,000
Large-mouthed black bass	6,790
Loch Leven trout	20,000
Rainbow trout	112,600
Sunfish	1,000
Connecticut:	
Brook trout	47,000
Catfish	10,000
Crappie	80
Flounder	†19,354,000

State and species.	Number.
Connecticut—Continued.	
Large-mouthed black bass	495
Pike perch	†1,000,000
Small-mouthed black bass	621
Yellow perch	†200,000
	525
Delaware:	
Brook trout	1,200
Large-mouthed black bass	1,050
Rock bass	540
Sunfish	60
Georgia:	
Brook trout	†10,000
Catfish	3,150
Crappie	475
Large-mouthed black bass	†13,000
	84,285
Rainbow trout	67,600
Small-mouthed black bass	100
Sunfish	48,200
Hawaii: Rainbow trout	*51,000
Idaho:	
Black-spotted trout	10,500
Brook trout	15,950
Chinook salmon	224,000
Landlocked salmon	*5,000
Rainbow trout	*125,000
	87,000
Whitefish	*1,000,000
Illinois:	
Buffalo fish	*19,292,000
	380,200
Carp	301,460
Catfish	572,115
Crappie	315,665
Fresh-water drum	10
Large-mouthed black bass	8,622
Pike and pickerel	50
Rock bass	240
Small-mouthed black bass	1,500
Sunfish	744,815
White bass	1,560
Yellow perch	25
Miscellaneous fishes	20,000
Indiana:	
Carp	110
Catfish	3,150

FIG. 3.—Applicant receiving fish from Bureau of Fisheries distribution car attached to regular passenger train.

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Indiana—Continued.	
Crappie	2,820
Large-mouthed black bass	9,342
Pike perch	*13,800,000
	†3,000,000
Rainbow trout	†36,000
	600
Rock bass	1,400
Small-mouthed black bass	†151,000
	22,575
Sunfish	17,100
Yellow perch	525
Iowa:	
Brook trout	47,400
Buffalo fish	*37,764,250
	1,709,855
Carp	10,799,690
Catfish	16,002,860
Crappie	8,844,235
Fresh-water drum	213,150
Lake trout	*50,000
Large-mouthed black bass	62,296
Pike and pickerel	18,140
Pike perch	*5,100,000
	†60,000
	340
Rainbow trout	*206,000
	21,600
Rock bass	2,800
Sunfish	20,204,019
Warmouth bass	1,860
White bass	7,190
Yellow perch	42,275
Miscellaneous fishes	6,337,445
Kansas:	
Catfish	3,100
Crappie	220
Large-mouthed black bass	5,470
Sunfish	400
Yellow perch	*5,000,000
Kentucky:	
Catfish	3,000
Crappie	2,740
Large-mouthed black bass	1,995
Rock bass	1,140
Small-mouthed black bass	†137,000
	1,500
Sunfish	56,290
Yellow perch	†225,000
	235
Louisiana:	
Buffalo fish	*29,850,000
	†51,000,000
Crappie	530
Large-mouthed black bass	2,750
Sunfish	8,100
Maine:	
Atlantic salmon	†1,334,000
	180
Brook trout	†782,430
	142,800
Flounder	†922,777,000
Humpbacked salmon	†369,860
Lake trout	*50,000
Landlocked salmon	†187,230
	67,860
Large-mouthed black bass	240
Rainbow trout	†16,000
Small-mouthed black bass	†22,000
	385
Smelt	†300,000
Maryland:	
Brook trout	16,600
Chinook salmon	6,000
Lake herring	*1,000,000

State and species.	Number.
Maryland—Continued.	
Large-mouthed black bass	4,460
Rainbow trout	*135,000
	35,175
Rock bass	260
Shad	†16,048,600
Sunfish	1,200
Yellow perch	†43,863,000
Massachusetts:	
Brook trout	*5,000
	181,520
Buffalo fish	250
Catfish	6,000
Cod	*208,224,000
	†232,131,000
Flounder	*198,268,000
	†925,247,000
Haddock	*75,960,000
	†290,820,000
Large-mouthed black bass	390
Mackerel	†1,980,000
Pike perch	†1,600,000
Pollock	†327,380,000
Rainbow trout	40,827
Sea bass	†32,000
Scup	†2,505,000
Small-mouthed black bass	†8,000
	890
Steelhead salmon	†20,000
Sunfish	400
Yellow perch	†200,000
	105
Michigan:	
Brook trout	†60,000
	153,500
Catfish	1,800
Crappie	625
Lake herring	*32,500,000
Lake trout	*36,000
	†24,973,000
	66,000
Large-mouthed black bass	9,285
Pike perch	*56,550,000
Rainbow trout	*50,000
	†52,000
	33,000
Rock bass	200
Small-mouthed black bass	†82,750
	23,267
Sunfish	1,625
Whitefish	*160,000
	†68,950,000
Yellow perch	600
Minnesota:	
Brook trout	98,700
Buffalo fish	61,506
Carp	3,483,945
Catfish	8,946,375
Crappie	12,577,125
Fresh-water drum	25,585
Lake trout	*1,200,000
	†1,700,000
	85,000
Large-mouthed black bass	177,825
Pike and pickerel	598,673
Pike perch	†150,000
Rainbow trout	†13,600
	47,200
Sunfish	11,728,971
Steelhead salmon	*50,000
White bass	14,460
Whitefish	†800,000
Yellow perch	1,209,725
Miscellaneous fishes	14,450

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Mississippi:	
Crappie	450
Large-mouthed black bass	†27,940
	174,000
Sunfish	71,650
Missouri:	
Catfish	200
Crappie	4,310
Large-mouthed black bass	46,656
Rainbow trout	*143,000
	311,822
Rock bass	1,218
Small-mouthed black bass	223
Sunfish	50,095
Yellow perch	*4,000,000
	†600,000
Montana:	
Black-spotted trout	*437,500
	†425,000
	442,000
Brook trout	431,575
Catfish	11,530
Chinook salmon	*100,000
Lake trout	*100,000
Large-mouthed black bass	750
Rainbow trout	*315,000
	†30,000
	415,500
Steelhead salmon	*72,000
Sunfish	115
Whitefish	*5,000,000
Nebraska:	
Brook trout	23,950
Large-mouthed black bass	625
Rainbow trout	10,000
Nevada: Rainbow trout	*100,000
New Hampshire:	
Brook trout	†478,120
	364,550
Catfish	600
Lake trout	†5,900
	24,450
Landlocked salmon	20,000
Pike perch	†1,000,000
Rainbow trout	18,880
Small-mouthed black bass	†9,500
New Jersey:	
Brook trout	900
Catfish	100
Lake trout	*25,000
Large-mouthed black bass	2,850
Rainbow trout	1,350
Yellow perch	90
New Mexico:	
Brook trout	109,500
Carp	60
Catfish	2,125
Crappie	2,430
Large-mouthed black bass	300
Rainbow trout	*75,000
	3,000
Rock bass	400
Sunfish	815
Yellow perch	100
New York:	
Black-spotted trout	*10,000
Brook trout	†479,500
	47,100
Catfish	1,550
Crappie	275
Lake herring	*72,890,000
	47,400,000
Lake trout	*1,010,000
	†756,000
Landlocked salmon	*10,000
	4,800

State and species.	Number.
New York—Continued.	
Large-mouthed black bass	4,365
Pike perch	†400,000
Rainbow trout	*10,000
	†157,500
	21,000
Rock bass	†300
	1,000
Small-mouthed black bass	175
Steelhead salmon	*60,000
Sunfish	220
Whitefish	*34,950,000
	†32,000,000
Yellow perch	*400,000
	†11,500,000
	235
North Carolina:	
Brook trout	†90,000
	85,500
Crappie	45
Glut herring	†82,600,000
Large-mouthed black bass	†36,400
	31,379
Rainbow trout	500,910
Rock bass	3,000
Shad	†27,459,000
Small-mouthed black bass	1,500
Striped bass	†25,530,000
Sunfish	14,990
Warmouth bass	155
North Dakota:	
Catfish	6,200
Crappie	380
Large-mouthed black bass	1,390
Rainbow trout	1,500
Sunfish	5,360
Yellow perch	700
Ohio:	
Brook trout	530
Buffalo fish	4,320
Carp	†82,050,000
Catfish	5,400
Crappie	250
Large-mouthed black bass	5,418
Pike perch	†42,500,000
Rainbow trout	*21,600
	2,700
Rock bass	4,000
Small-mouthed black bass	†57,000
	16,050
Steelhead salmon	*25,000
Sunfish	9,550
Whitefish	†204,600,000
Yellow perch	*25,000,000
	†16,000,000
	575
Oklahoma:	
Catfish	2,050
Crappie	2,810
Large-mouthed black bass	8,740
Rainbow trout	95,900
Rock bass	800
Sunfish	4,165
Yellow perch	455
Oregon:	
Black-spotted trout	13,000
Brook trout	†50,000
	1,000
Chinook salmon	*1,300,000
	†1,311,550
	11,412,650
Grayling	†25,000
Rainbow trout	57,963
Silver salmon	110,000
Steelhead salmon	*20,000
	1,662,420

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Pennsylvania:	
Brook trout	550,845
Carp	300
Catfish	13,700
Crappie	300
Lake herring	*114,300,000
Lake trout	*50,000
Large-mouthed black bass	15,609
Pike perch	*4,200,000
	†500,000
Rainbow trout	*50,000
	284,450
Rock bass	†700
	1,060
Steelhead salmon	*50,000
Sunfish	11,035
Whitefish	*32,340,000
Yellow perch	†3,500,000
	830
Rhode Island: Small-mouthed black bass	†2,000
South Carolina:	
Brook trout	†5,000
	9,000
Catfish	190
Crappie	200
Large-mouthed black bass	†103,145
	118,100
Rainbow trout	29,000
Sunfish	8,310
Warmouth bass	500
South Dakota:	
Brook trout	249,350
Catfish	550
Crappie	560
Large-mouthed black bass	4,950
Loch Leven trout	27,000
Rainbow trout	165,500
Sunfish	1,150
Yellow perch	100
Tennessee:	
Brook trout	†3,000
	1,500
Catfish	1,600
Crappie	1,700
Large-mouthed black bass	10,395
Rainbow trout	*50,000
	101,800
Rock bass	9,075
Small-mouthed black bass	5,655
Sunfish	13,800
Yellow perch	80
Texas:	
Catfish	37,500
Crappie	565
Large-mouthed black bass	576,520
Rock bass	845
Sunfish	85,050
Utah:	
Brook trout	*250,000
	83,260
Lake trout	*100,000
Rainbow trout	553,500
Vermont:	
Brook trout	†590,000
	60,000
Lake trout	*25,000
	†149,465
	7,940
Landlocked salmon	3,125
Pike perch	†5,237,500
Rainbow trout	9,000
Small-mouthed black bass	524

State and species.	Number.
Vermont—Continued.	
Steelhead salmon	*50,000
Yellow perch	†5,000,000
Virginia:	
Brook trout	65,200
Catfish	904
Crappie	2,165
Large-mouthed black bass	†17,764
	66,500
Rainbow trout	267,700
Rock bass	13,435
Shad	†19,953,600
Small-mouthed black bass	†10,000
	375
Sunfish	38,600
Yellow perch	†124,239,200
Washington:	
Black-spotted trout	10,000
Brook trout	120,400
Chinook salmon	40,255,010
Chum salmon	†1,540,000
	14,027,620
Grayling	†225,000
Humpbacked salmon	909,400
Rainbow trout	12,000
Silver salmon	†600,000
	10,964,940
Sockeye salmon	†4,200,000
	7,702,365
Steelhead salmon	*123,000
	365,800
West Virginia:	
Brook trout	148,430
Catfish	625
Crappie	100
Large-mouthed black bass	†9,000
	6,445
Rainbow trout	364,150
Rock bass	1,200
Small-mouthed black bass	†26,000
Sunfish	3,075
Yellow perch	†1,500,000
Wisconsin:	
Brook trout	760,240
Buffalo fish	1,185,355
Carp	7,421,240
Catfish	26,488,666
Crappie	14,706,310
Fresh-water drum	3,280
Lake trout	†1,775,000
Large-mouthed black bass	95,880
Pike and pickerel	62,932
Pike perch	†450,000
	34,050
Rainbow trout	†25,600
	152,933
Rock bass	1,240
Sunfish	19,494,490
White bass	13,300
Whitefish	*21,600,000
Yellow perch	347,170
Miscellaneous fishes	4,030,460
Wyoming:	
Black-spotted trout	*250,000
	†68,400
	106,500
Brook trout	462,750
Catfish	3,000
Lake trout	*100,000
Large-mouthed black bass	3,000
Loch Leven trout	9,000
Rainbow trout	*446,240
	†80,000
	585,500
Rock bass	1,000

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1922—Continued.

FOREIGN COUNTRIES.

Country and species.	Number.	Country and species.	Number.
Canada:		Switzerland:	
Black-spotted trout [1]	* 200,000	Lake trout	* 50,000
Landlocked salmon [1]	* 100,000	Rainbow trout	* 50,000
Rainbow trout [1]	* 450,000		
Whitefish	* 61,192,000	Total	* 62,142,000
Czechoslovakia: Rainbow trout	* 100,000		

[1] In exchange for an equal number of Atlantic-salmon eggs.

ASSIGNMENTS TO STATE AND TERRITORIAL FISH COMMISSIONS.

Those States and territory in which part of the output distributed was assigned to the State and Territorial Fish Commissions as applicants are given in the following table, showing the number and species of fish and fish eggs delivered to each such commission.

Assignments of fish and fish eggs to State and Territorial Fish Commissions, fiscal year 1922.

[Asterisk (*) denotes eggs; dagger (†), fry; all others are fingerlings.]

State and species.	Number.	State and species.	Number.
Hawaii: Rainbow trout	* 51,000	New Jersey: Lake trout	* 25,000
Idaho: Whitefish	* 1,000,000	New Mexico:	
Illinois:		Brook trout	36,000
Black bass	227	Rainbow trout	* 75,000
Carp	100	New York:	
Catfish	15,165	Cisco	* 16,050,000
Crappie	4,800	Lake trout	* 1,000,000
Drum	10	Steelhead salmon	50,000
Pike	50	Whitefish	* 15,000,000
Rock bass	40	North Dakota:	
Sunfish	30,800	Black bass	930
Yellow perch	25	Catfish	5,600
Indiana: Pike perch	* 13,800,000	Crappie	280
Iowa:		Sunfish	4,380
Brook trout	41,500	Yellow perch	700
Lake trout	* 50,000	Oklahoma: Rainbow trout	113,500
Pike perch	* 5,100,000	Oregon:	
Rainbow trout	* 206,000	Chinook salmon	* 1,300,000
	1,500	Grayling	† 25,000
Kansas: Yellow perch	* 5,000,000	Pennsylvania:	
Maine: Lake trout	* 50,000	Catfish	200
Maryland:		Cisco	*114,300,000
Cisco	* 1,000,000	Lake trout	* 50,000
Chinook salmon	5,000	Pike perch	* 4,200,000
Rainbow trout	* 135,000	Steelhead salmon	*50,000
Massachusetts:		Whitefish	* 32,340,000
Buffalo fish	250	Tennessee: Rainbow trout	* 50,000
Catfish	4,000		16,000
Michigan:		Utah:	
Cisco	* 32,500,000	Brook trout	* 250,000
Lake trout	600,000	Lake trout	* 100,000
Rainbow trout	* 50,000	Vermont:	
Pike perch	* 56,500,000	Lake trout	*25,000
Albino brook trout	10,000		91,865
Minnesota:		Rainbow trout	3,000
Black bass	6,395	West Virginia: Rainbow trout	116,000
Crappie	3,150	Wisconsin:	
Lake trout	* 1,200,000	Black bass	6,790
Steelhead salmon	* 50,000	Catfish	1,920
Sunfish	39,050	Crappie	660
Yellow perch	120	Sunfish	8,400
Missouri:		Yellow perch	2,975
Rainbow trout	* 143,000	Whitefish	* 21,000,000
	36,280	Wyoming:	
Yellow perch	* 4,000,000	Black-spotted trout	* 250,000
Montana:		Brook trout	24,000
Black-spotted trout	* 587,500	Lake trout	* 100,000
Chinook salmon	* 100,000	Rainbow trout	* 446,240
Lake trout	* 100,000		
Rainbow trout	* 215,000	Total	* 333,570,740
Steelhead salmon	* 72,000		1,245,662
Whitefish	* 5,000,000		† 25,000
New Hampshire: Lake trout	14,000		

DISTRIBUTION METHODS AND EQUIPMENT.

IMPROVEMENTS TO FISHERIES CAR NO. 9.

By making a slight change in the interior arrangement of fisheries car No. 9, one of the new steel cars, it has been possible to increase its carrying capacity from 140 to 156 cans. This has been brought about by fitting up a small dining room at one end of the can compartments, thereby permitting the utilization of the space in the center of the car for carrying fish. The new arrangement, besides resulting in economy for the bureau in that it allows a larger load of fish to be carried, is found more satisfactory than the old, as the table in its new position is made stationary and can be used by the messengers in writing up reports. Besides, it is so located that it permits of an unobstructed passageway through the car at all times.

USE OF GALVANIZED VESSELS IN TRANSPORTING LIVE FISH.

Because of a rather general belief among fish-culturists that galvanized vessels are not suitable for the transportation of living fishes, the bureau conducted a number of experiments with such vessels during the year. The following extract from the Fisheries Service Bulletin No. 83, for April 1, 1922 (pp. 3–4), briefly outlines the results:

> On car No. 7 a galvanized-iron bucket 13½ inches high and 13½ inches in diameter (the ordinary type of garbage can) was used throughout the season without loss of fish. On one occasion black bass were transported in such a can from Dubuque, Iowa, to Baltimore, Md. From that point they were forwarded by special messenger on a 12-hour trip to the applicant, and the fish were delivered in excellent condition. Again, on a trip from La Crosse, Wis., to Mammoth Spring, Ark., some of the largest black bass intended for brood stock were carried in this can without loss. This vessel was treated in every respect, including the numbers of fish carried, in a manner similar to the general practice in transporting fish. Results were equally satisfactory in transporting all other species handled throughout the season. On car No. 8, 100 rock bass (No. 2 fingerlings) were moved from Marquette, Iowa, to Eaton, N. Mex. The fish were received on the car October 24 and reached their final destination November 2 without loss. On the same date and at the same place 30 yearling crappie were placed in a galvanized-iron bucket with 8 gallons of water and were delivered to an applicant at Trinidad, Colo., on November 2, with a loss of five fish on a trip of nearly eight days' duration.
>
> The only precaution necessary in the use of galvanized vessels in transporting live fish is apparently their thorough cleaning prior to use. Galvanized vessels possess certain advantages over tinned vessels now in general use. They are practically immune from rust, their cost is considerably less, and it is the belief of many fish-culturists that the duller-surfaced material produced by galvanizing is preferable to a tinned surface, from the fact that it reflects less light, and thus provides more nearly normal surroundings for the fish.

Further experiments along this line have been conducted recently, the result in each case tending further to prove that galvanizing is not harmful to fish. The recent experiments involve such species as rainbow, brook, and lake trouts, and whitefish fry and fingerlings. The fish were in transit for periods ranging from 6½ to 35½ hours without change of water, and in each case they arrived at destination in good condition.

NEW METHOD OF SHIPPING LIVE FISH WITHOUT ICE OR ATTENDANT.

One of the problems that the bureau has recently been called upon to solve is the distribution of fish in increasing numbers without additional funds to meet the increased transportation charges. In view of the facts that passenger, freight, and express rates are now higher than at any period in our history, and that there is an insistent demand for economy in both Government and private business, it has seemed most opportune to undertake a new method of shipping live fish without ice and, in many instances, without the usual attendant. The possibilities in economy over the present method of shipping by messenger are readily apparent.

EXPERIMENTS WITH DIFFERENT CANS.

Experiments made with lard cans placed in loosely fitted bags of 10-ounce canvas with means for keeping the canvas moist tend to show that an even temperature can be maintained, and that when the margin between the air and water temperature is not too great the temperature of the water may be considerably reduced through evaporation. The underlying principle involved in the plan is the cooling effect of evaporation, and since heat greatly stimulates evaporation, the principle might be successfully applied, within certain reasonable limits, in almost direct ratio to the need.

The following table indicates the results of some experiments conducted along this line:

Experiments showing comparable results with different cans under varying conditions.

Day and hour.	Air temperature.	Water temperature (°F.).					Location of can.
		Standard 10-gallon can.	Lard can, wet sack.	Lard can without jacket.	Lard can, dry canvas jacket.	Lard can, wet canvas jacket.	
June 20:							
9.30 a. m.	79	48	48	.....	.....	48	In yard at bureau.
12.30 p. m.	90	70	62	.....	.....	62	
2.30 p. m.	92	77	68	.....	.....	68	
3.30 p. m.	80	78	70	.....	.....	70	
June 28:							
10 a. m.	84	81	.....	81	.....	81	Indoors; tops open.
12 noon	87	81½	.....	81½	.....	80	
4 p. m.	89	81½	.....	81½	.....	78	
June 29:							
9.30 a. m.	79	56	.....	56	.....	56	In shade; tops open.
1.30 p. m.	87	68	.....	68	.....	66	
3.30 p. m.	84½	72	.....	72	.....	69½	
July 26:							
9.15 a. m.	84	.....	.....	80	80	80	In shade in yard at bureau.
1.15 p. m.	95	.....	.....	84	82	76	
4.15 p. m.	94	.....	.....	85½	82	75	
9 a. m.[1]	83	.....	.....	80	78	73	
July 27:							
9.30 a. m.	85	.....	.....	81	81	81	In sun in yard at bureau.
11.30 a. m.	113	.....	.....	86	84	80½	
1.30 p. m.[2]	111	.....	.....	89	88	81	
4.15 p. m.	101	.....	.....	92	89½	80½	

[1] Following morning; jacket still moist.

[2] Moistened jacket of cans.

It is not intended to convey the idea that special attendants will not be necessary in handling large shipments of fish or under particularly difficult conditions, but by taking a large number of cans to some central point and sending allotments of fish to the various applicants one man should be able to cover a given territory more expeditiously and economically than is possible under the present system. Reaching applicants residing at points off the main railroad lines usually involves extra expense, since the attendant, because of irregular train service, frequently has been obliged to remain over night at the point where the last delivery of fish was made.

The lard can and jacket complete costs less than $1.50. The jacket represents about 65 per cent of the total cost. In short-distance shipments, where express charges are not high, the cans may be returned for reuse. In cases where there would be excessive express charges the recipient of the fish may be requested to return the jackets only, by parcel post, a frank being furnished for the purpose.

PRACTICAL APPLICATIONS.

A specific instance of the results obtained by this method is illustrated by the following in connection with the distribution from the Orangeburg (S. C.) station in the fall of 1921. A messenger with 20 cans of black bass and bluegills left Orangeburg at 5.30 a. m. He supplied 17 applicants at 9 points, and returned to the station at 11 p. m. on the same date, the entire expense in connection therewith being $21.47. The method of procedure was from Orangeburg to Fayetteville (N. C.), where six applicants were supplied. From Fayetteville fish were forwarded in jacketed cans, in care of the train baggage-masters, to 11 applicants. Had the messenger delivered fish to each applicant in person 65½ hours would have been required, and the cost would have been practically doubled. The cost of distribution from the Orangeburg station during the fall of 1920 under the old method was $1.57 per can of fish distributed; the cost under the new method during 1921 was 90 cents per can.

From the Bullochville (Ga.) station 28 deliveries were made on four messenger trips. On one trip to Atlanta, Ga., 10 shipments of fish were made to points in Tennessee, Alabama, North Carolina, and Georgia. No complaints were received.

In the fall of 1920 a special shipment of Gambusia was sent by messenger from Edenton, N. C., to Washington, D. C., the cost of the trip being approximately $25. Practically the same number of Gambusia was shipped to Washington, D. C., in the fall of 1921 in two jacketed cans, the express charges being only $1.57.

At the Edenton (N. C.) station a reduction of approximately 50 per cent in the distribution costs was brought about during the fiscal year 1922 by generally adopting the new method. Messengers with fish for distribution were sent to the three important railroad centers—Greensboro, Raleigh, and New Bern, N. C.—and the consignments were forwarded to applicants from those points by express or in care of the train baggage-masters. No complaints came to hand of failure to receive fish or of fish received in poor condition. The following statement shows the actual costs of making

the distribution of sunfish from the Edenton (N. C.) station for the fiscal years 1921 and 1922:

Comparative costs per trip of distribution of sunfish from Edenton (N. C.) station, fiscal years 1921 and 1922.

Destination.	Number of applicants supplied.	Number of cans.	Number of fish.	Cost.
Old method (1920):				
Raleigh, N. C.	6	12	1,800	$32.94
Catawba, N. C.	5	13	1,910	32.00
Chapel Hill, N. C.	8	16	2,519	20.14
Raleigh, N. C.	8	17	2,350	30.84
Mount Gilead, N. C.	4	8	1,200	36.40
Total, 1920	31	66	9,779	152.32
Average cost per thousand				15.57
New method (1921):				
Greensboro, N. C.	21	21	2,650	24.19
Raleigh, N. C.	22	22	2,125	17.49
New Bern, N. C.	19	20	3,400	21.15
Total, 1921	62	63	8,175	62.53
Average cost per thousand				7.64

NEW EQUIPMENT FOR USE IN SHIPPING LIVE FISH.

In connection with the foregoing a number of new devices making for greater economy and efficiency have been developed during the year, and are discussed and illustrated in the following pages.

FISH-TRANSPORTATION PAIL.

This device, developed by E. C. Fearnow, superintendent of fish distribution, United States Bureau of Fisheries, was patented June 13, 1922 (see agreement and license below), and the drawing and descriptive text are taken from the United States Patent Office specification of letters patent No. 1419549. (See fig. 4, p. 94.)

AGREEMENT AND LICENSE.

Whereas Edgar C. Fearnow, a resident of Capitol Heights, in the county of Prince Georges and State of Maryland, has invented a container for transporting live fish and has filed on March 6, 1922, an application for United States letters patent thereon, serial No. 541500; and

Whereas the said Edgar C. Fearnow is desirous of granting, and the United States Government of receiving, rights in and to said invention and any patent granted thereon:

Now, therefore, in consideration of one dollar ($1) and other valuable considerations paid by the United States Government to the said Edgar C. Fearnow, the receipt of which is hereby acknowledged, the said Edgar C. Fearnow agrees to and does hereby grant to the United States Government, and to each and all of its component departments, a license to employ the device described and claimed in said application and in any patent granted upon or covering said invention to the full end of the term or terms thereof, and to make and use and to have made and to have used by others, all for United States governmental purposes only, any substance, material, or article embodying said invention.

And the said Edgar C. Fearnow covenants for himself, his legal representatives, and assigns, that he owns and controls the entire right, title, and interest in and to said invention, and application for patent, and that no representation has been made nor any instrument executed by him inconsistent herewith.

The United States retains, notwithstanding anything in this agreement, all rights which it has by virtue of the act of June 25, 1910, as amended by the act of July 1, 1918.

S. W. STRATTON,
Acting Secretary of Commerce for the United States.

Personally appeared before me Edgar C. Fearnow, known to me to be the person named in the foregoing agreement and license, who executed the same in my presence and acknowledged the execution of this instrument to be his free act and deed, on this 14th day of March, 1922.

E. W. LIBBEY, *Notary Public.*

The container consists of an outer receptacle *1*, made of any suitable size and material with a series of perforations or vents *2* somewhat below the upper edge for the purpose of admitting air into the interior in case something is set on top of the container.

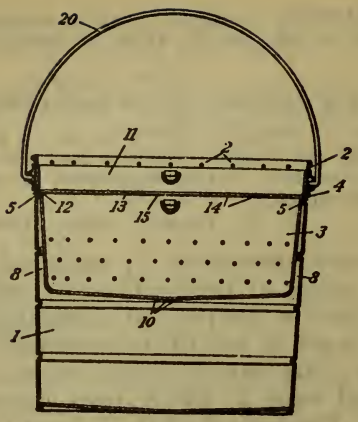
The bottom compartment or tray *3* fits into the outer receptacle *1*, being held in place by the flanged edge *4*, which rests upon the shoulder *5* of the outer receptacle. The body *6* of the bottom tray *3* is pierced by a number of small apertures *7*, said body tapering from top to bottom more rapidly than the sides of the outer receptacle *1*, providing an air space *8* between the sides of the bottom tray *3* and the outer receptacle *1*. The bottom *9* of the tray *3* is shown dished downwardly somewhat and also perforated by several small holes *10* in the center.

The upper tray *11* also fits into the outer receptacle *1*, the lower edge *12* resting upon the shoulder *5* of the outer receptacle. The bottom *13* of the upper tray *11* is perforated with a series of small apertures *14* and may also have a large central hole *15* to permit inspection of the interior.

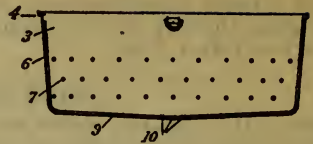
In use the receptacle *1* is partially filled with water of a predetermined temperature until the depth in the bottom tray *3* is sufficient to submerge the bodies of the fish. An absorbent jacket *16* may then be drawn over the container and its inner flap *17* folded inwardly and down over the edge of the outer receptacle *1*. Then the upper tray *11* is placed within the receptacle *1* and the inner flap *17* of the absorbent jacket *16* is thus held in position between the outer receptacle *1* and the upper tray *11*, the width of the flap *17* being sufficient to permit it to extend below the bottom of the upper tray. The jacket *16* may then be moistened and is maintained in that state by the wicklike action of the flap *17* and the splashing of water from the lower trap *3* onto the projecting edge of the flap *17*. The evaporation of moisture in the jacket *16* draws heat from the interior of the container, thereby keeping the water sufficiently cool to permit the fish to live.

The outer flap *18* of the absorbent jacket *16* is shown split to permit it to be drawn over the top of the container and fastened by means of a drawstring *21* passing through the eyelets *19* without interfering with the bail *20*.

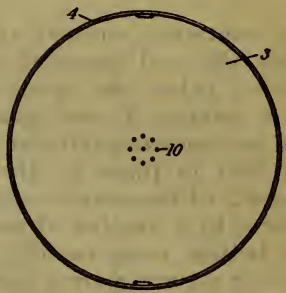
Automatic aeration is accomplished by the invention in the following manner: The fish in the bottom tray *3* are compelled to remain almost at the surface of the water where the greatest amount of oxygen is present. When the container is in motion, the swaying and jolting thereof will cause the water in the outer receptacle to move from side to side. Since water is incompressible and the body of water in the lower part of the outer receptacle *1* entirely fills the



A



B



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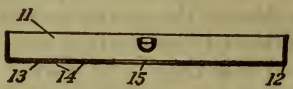
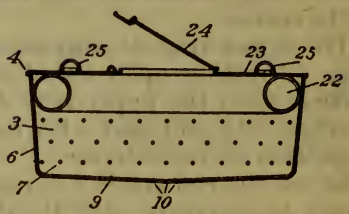
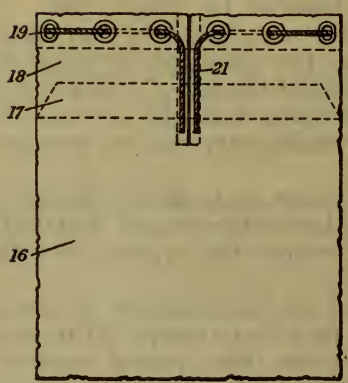


D

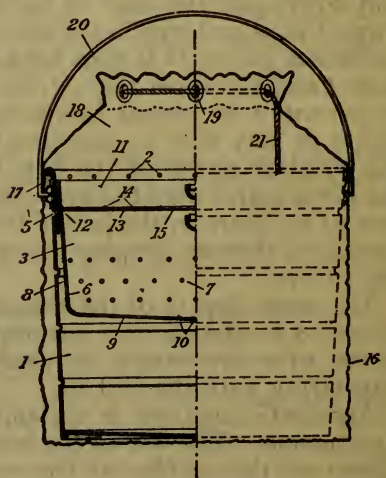
E



G



F



H

FIG. 4.—The Fearnow self-aerating fish transportation pail with canvas jacket. *A*, Vertical section of container; *B*, vertical section of lower tray; *C*, plan view of lower tray; *D*, vertical section of top tray; *E*, plan view of top tray; *F*, elevation of jacket; *G*, vertical section of a tray that may replace other trays in case container is used as a minnow or bait pail; *H*, side elevation, partly in section, of container with absorbent jacket in position.

space between the bottom and sides of the outer receptacle *1* and the bottom of lower tray *3*, this body of water can move only by virtue of the air space *8* between the sides of the outer receptacle *1* and lower tray *3*, with the result that a portion of the water will be forced up into the air space *8* with considerable violence and pressure by the mass movement of the body of water in the lower part of the outer receptacle and will pass in small jets from the space *8* into the lower tray *3*, not only through the perforations *7* in its sides, which are below the normal surface of the water, but also through the perforations *7* which are above the surface of the water, falling therefrom through the air into the lower tray *3* and becoming aerated by its passage through the air.

The amount of water thus forced into the lower tray *3*, will, because of the pressure to which it is subjected, be somewhat greater than the quantity which will flow out by its own weight through the limited number of perforations *10* below the surface, with a result that the level of water in the lower tray will be raised somewhat above the level of the water in the outer receptacle until a point is reached where the area of the perforations submerged by the water within the lower tray *3* is sufficient to compensate for this forced injection. In this way a higher level of water is maintained within the lower tray *3*, which affords the fish greater freedom of action while the container is in motion.

When the container is stationary, the water level within the lower tray *3* immediately returns to its normal level to be determined by the character of fish to be shipped. For example, in shipping large fish as distinguished from fry, the water should be of sufficient depth to permit the fish to swim about with their dorsal fins exposed above the surface. The fish then assist in the aeration of the water.

When the supply of oxygen in the water becomes depleted, the fish begin to feel discomfort, which manifests itself in increased activity on their part and results in the splashing about of the water because of its extreme shallowness.

The upper tray *11* acts as a cover and baffle plate whenever the motion of the container is sufficient to cause the water to splash against it. The perforations *14* in the bottom of the upper tray *11* are of such dimensions that the water can not pass through in sufficient volume or with sufficient force to slop over, but will percolate back into the bottom tray *3*, becoming aerated in the process.

The upper tray *11* also serves as a receptacle for supporting ice when considered necessary; as, for example, when shipping cold-water fish, such as trout, in extremely hot weather. The perforations *14* permit the ice water to drip into the bottom tray *3*, carrying with it a large supply of oxygen. Under such circumstances the outer flap *18* of the absorbent jacket *16* is drawn over the ice and retained in position by fastening means, such as drawstrings *21*.

The bottom *9* of the tray *3* is shown slightly dished and perforated at its lowest point, the center *10*. The excrement of the fish settles to the bottom of the tray *3* and passes through perforations at the center *10* into the lower part of the container where it settles and remains on the bottom because of the comparative stillness of the water in that part.

If desired, the bottom tray *3* may be provided near its upper edge with a buoyant member *22*, so that it will float and may be towed behind a boat during the collection of the fish to be transported. Such an arrangement is shown by *G* (fig. 4).

G also shows a desirable construction of bottom tray *3* when the container is to be used as a minnow bucket or fisherman's live-bait pail. Float *22* is shown secured to the inside of bottom tray *3* near its upper edge. The cover *23*, having a hinged lid *24*, may be added. This device may be secured to a boat or other convenient object by means of a cord attached to rings *25*. Furthermore, it may be placed within the outer receptacle *1* and will then perform the functions of the simple bottom tray *3* heretofore described, in addition to its function as a floating pail.

This pail as adopted by the bureau, although only 12 inches high and 13½ inches in diameter, carries as many fish as are commonly placed in the regulation 10-gallon milk can. As it is possible to place five of these pails in the space occupied by three milk cans, the carrying capacity of the cars has been increased 66⅔ per cent. The device is especially useful in shipping fish for considerable distances without an attendant. It also affords a practical means of transporting fish to the headwaters of streams that have heretofore been neglected on account of their inaccessibility.

AUTOMATIC SIPHON AND IMPROVED TRAY FOR ICE.

The automatic siphon for removing pollution from fish cans and maintaining a water level, thereby facilitating the changing of water on fish, and the improved type of tray for ice were designed by E. C. Fearnow and patented under the act of March 3, 1883 (22 Stat. L. 625). (See fig. 5.) The object of the invention is, primarily, to provide a simple and efficient means for removing sediment and pollution from the container, and, secondarily, to provide means for maintaining the water level at a substantially fixed point. These results are accomplished by combining with a tank or a container of any desired type a siphon so arranged that by tilting the container, or by the addition of water to the container, the siphon may be submerged and caused to operate to remove sediment and polluting matter and to reduce the quantity of water within the container to a predetermined amount.

The device illustrated by *A* (fig. 5) consists of the container *1*, which, in this instance, resembles an ordinary 10-gallon milk can. This shape has been extensively used by hatcheries for the shipment of live fish, because water is not likely to slop out of it unless it is filled too full. The bottom *2* of the container is shown dished downwardly somewhat and is connected with the body of the container a short distance above the lower edge, as at *3*, so that a space will be preserved between the bottom and any surface upon which the container may be placed. Within the container is a siphon *4*, shown as a pipe, principally in the shape of an inverted U. The top *5* of the siphon is located at the highest point to which it is desired to permit the water within the container to rise. The intake legs *6* of the siphon passes through the bottom of the container and connects with

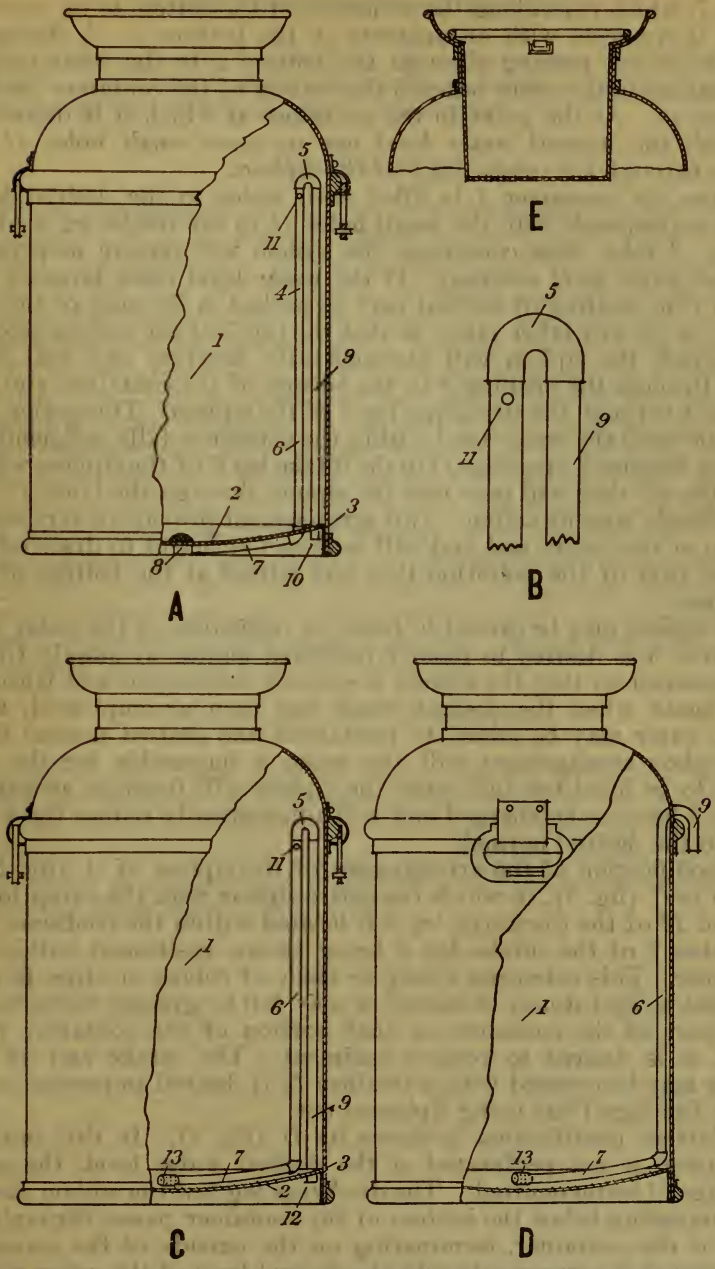


FIG. 5.—Automatic siphon used with ordinary fish transportation can for removal of sediment and surplus water, and improved tray for ice. *A*, Perspective view, partly broken away and in section, of a container equipped with the siphon; *B*, fragmentary vertical cross section of the siphon; *C* and *D*, perspective views, partly in section, of containers with modified forms of the siphon; *E*, vertical cross section of the upper part of a container with an improved type of tray for holding ice.

a pipe *7*, which runs along the underside of the bottom to its center *8*, where it connects with an aperture in the bottom *2*. A discharge leg *9* is shown passing through the bottom *2* to the container *10*, terminating in the space beneath the bottom of the container already referred to. At the point in the container at which it is desired to establish the normal water level one or more small holes *11* are drilled through the intake leg *6* of the siphon.

In use the container *1* is filled with water to the desired level, which corresponds with the small holes *11* in the intake leg *6* of the siphon. Under these conditions the siphon will remain inoperative and the water level constant. If the water level rises, however, because of the melting of ice that may be packed in the neck of the container, or for any other cause, so that the top *5* of the siphon becomes submerged, the siphon will automatically function and will draw water through the opening *8* in the bottom of the container and discharge it through the discharge leg *9* of the siphon. This action will continue until the water level within the container falls sufficiently to uncover the small openings *11* in the intake leg *6* of the siphon, whereupon the air that will pass into the siphon through the holes *11* will immediately stop its action. This arrangement provides a very strong suction at the intake end and will be found sufficient to draw off the greater part of the pollution that has settled at the bottom of the container.

The siphon may be caused to function regardless of the water level whenever it is desired to remove polluting matter by simply tilting the container so that the siphon is entirely submerged and tilting it back again when the desired result has been accomplished, after which water may be added to reestablish the desired normal level. The siphon arrangement will also make it impossible for the container to be filled too full, since the siphon will function as soon as its top *5* becomes submerged and will automatically reduce the water level to the desired normal.

A modification of the arrangement of the siphon of *A* (fig. 5) is shown in *C* (fig. 5), in which the entire siphon with the exception of the end *12* of the discharge leg *9* is located within the container, the extension *7* of the intake leg *6* being shown positioned within the container. This extension *7* may be made of rubber or other flexible material, so that it may be moved or may fall by gravity to the lowermost part of the container or that portion of the container from which it is desired to remove sediment. The intake end of this siphon may be covered with a strainer *13* if desired to prevent small fish or fish eggs from being siphoned out.

A further modification is shown by *D* (fig. 5). In this instance the siphon is not perforated at the desired water level, the small openings *11* being omitted. The discharge leg *9* of the siphon instead of terminating below the bottom of the container passes through the body of the container, terminating on the outside of the container at a point that corresponds with the desired level of the water within the container.

A covenient and improved form of receptacle for ice is illustrated by *E* (fig. 5), wherein a simple perforated pan is shown securely and conveniently mounted in the upper end of an ordinary can. The shape, of course, may be modified to adapt it to any type of container.

CANVAS JACKET FOR 10-GALLON CAN.

The canvas jacket, designed by E. C. Fearnow and illustrated in Figure 6, is found especially desirable when making shipments of fish to distant points during warm weather.

AERATING DEVICE.

This new aerating device for use in transporting live fish (fig. 7) was designed by M. A. Mason, engineer at the Cape Vincent (N. Y.) station. It consists of a hollow cylinder made of galvanized sheet iron 18 inches high by 6 inches in diameter. In the bottom are 28 one-half inch perforations from which fish are excluded by wire mesh fastened to the inside surface. At the top is a handle and a vent in the form of a ½-inch brass pipe extending upward 1¾ inches.

In use the cylinder is inserted in the can of fish with the vent open and allowed to fill with water. The vent is then closed by the thumb of the operator and the cylinder withdrawn to a height several inches above the water level of the can. By opening the vent the water in the cylinder falls back into the can through the perforations, much broken up, carrying the needed oxygen with it.

Some of the advantages claimed for this device are that it removes for aeration water from near the bottom of the can, whereas the dipper in ordinary use takes mostly surface water. A larger amount of water is aerated at one operation than is possible with the dipper, and there is less chance of injury to the fish.

COST OF DISTRIBUTION.

During the fiscal year 1922 the bureau honored 10,376 applications for fish as compared with approximately 10,000 in the fiscal year 1921. By the use of improved methods and the exercise of the most rigid economy the distribution cost was slightly lowered. The following table gives comparative figures concerning cost of distribution for the fiscal years 1921 and 1922.

Fiscal year.	Number miles traveled.		Number applications honored.	Cost of distribution.
	Cars.	Messengers.		
1921	85,060	385,988	10,000	$69,600.00
1922	77,128	306,215	10,376	62,428.96

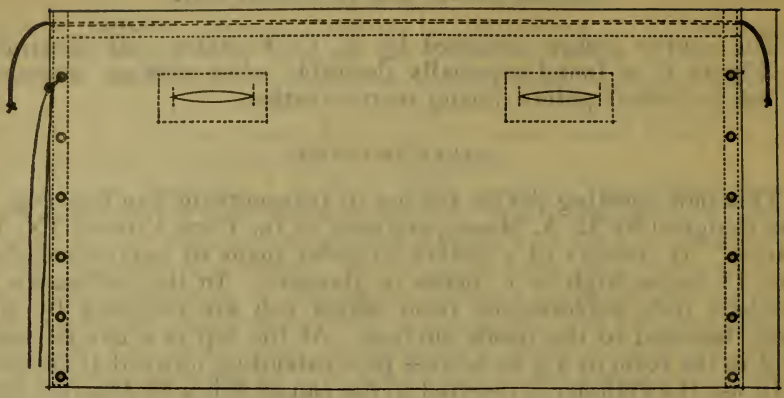


FIG. 6.—Canvas jacket for a 10-gallon fish transportation can for the purpose of maintaining temperature.

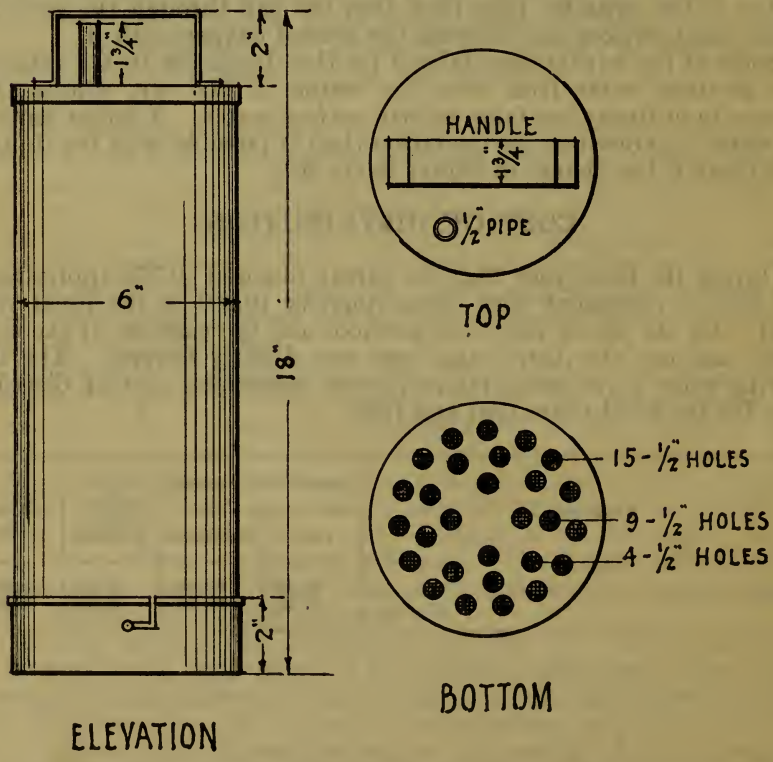


FIG. 7.—Aerating device to be used for removing water from fish-transportation can and breaking it into a fine spray.

STOCKING INTERIOR WATERS OF THE UNITED STATES.

By E. C. Fearnow, *Superintendent of Fish Distribution, U. S. Bureau of Fisheries.*

SPECIES DISTRIBUTED.

The cultivation of the fishes of the interior is an important feature of the bureau's work. The stocking of inland waters, public and private, is yearly becoming more generally appreciated, and a desire to actively cooperate in this work has been manifested throughout the country by persons interested in fishing as a business or for pleasure. Among the fishes most extensively propagated for this purpose are brook, rainbow, and black-spotted trouts, large-mouthed and small-mouthed black basses, rock bass, sunfish, crappie, and catfish. Various other species are also handled to a limited extent.

There are certain regions particularly well adapted as natural breeding grounds for such species as black bass, crappie, and bream, as for example, the State of Florida and the southern part of the State of Louisiana. It has not been found necessary to establish hatcheries in those States, since their supply of fish can best be increased by affording protection to the native species during their spawning seasons.

SPECIES LIMITED IN ASSIGNMENT.

SPINY-RAYED FISHES UNSUITED FOR TROUT AND SALMON WATERS.

The bureau adopted the policy some years ago of refusing all applications for black bass and allied species to stock waters of the Pacific States and Alaska now preeminent for their trout and salmon fisheries. This course was determined upon after a thorough canvass of the views of those most conversant with the situation and was indorsed by the officials of the States concerned. Although some waters of that section are not suited to trout or salmon, the few instances that may be cited do not impair the force of the bureau's contention for the exclusion of the species mentioned. There can be no denial of the fact that bass, sunfish, pike, and similar predacious fishes are antagonistic to trout and young salmon, and the bureau's experience has demonstrated the impracticability of confining the predatory species to specific waters where such are located in proximity to trout and salmon streams or lakes.

CARP CONSIDERED UNDESIRABLE BY MANY STATES.

As carp are considered undesirable by many of the State fisheries authorities, the bureau does not entertain applications for this species unless the requests bear the indorsement of the proper officials of the States in which the fish are to be planted. Even with this indorsement carp are not assigned for waters suited for the more desirable species.

ORNAMENTAL FISHES NOT DISTRIBUTED.

The bureau has no appropriation for the propagation of ornamental fishes nor has it any literature on goldfish breeding. Persons who desire information on this subject are advised to consult the standard goldfish works, which may be had at the public libraries. Ornamental fishes may be purchased from dealers in aquarium specialties.

RESCUE WORK.

For many years the bureau has been doing an important work of conservation by rescuing large numbers of native fishes from the temporary ponds and pools formed by the annual flooding of the Mississippi River and several of its tributaries. Over 99 per cent of the fish so rescued are returned to the parent streams and less than 1 per cent used for restocking depleted waters in the various States. Remarkable results have been attained in stocking small ponds on farms, and numerous cases are on record where ponds and lakes that contained no fish prior to their introduction by the bureau are now yielding a bountiful supply. Hundreds of favorable reports are annually received regarding this phase of the bureau's work.

DANGERS FROM OVERSTOCKING.

Overstocking is responsible in some instances for the small size fish attain. Applicants often request the introduction of new stock to correct this condition, whereas the remedy lies in reducing the number of fish to a point where the food supply will be sufficient to permit them to attain their maximum growth. By using in fish culture the same judgment that is exercised in stock raising the size of fish may be considerably increased and much better results obtained. A given area of ground will furnish forage for just so many cattle, and when more are added it means less food per capita. The same rule applies to fish, and no more should be placed in a body of water than the natural food supply will maintain. Young bass, crappie, and sunfish require natural food, and it is for this reason that any surplus fish should be removed to other waters in which a supply of suitable food is available.

METHODS OF INCREASING FISH SUPPLY.

Well-stocked streams and lakes add to the food supply of the country and also provide recreation for a large number of persons. As a recreation fishing is more generally engaged in than hunting, since the open season occurs during the vacation period. Good fishing often attracts attention to desirable sections that might otherwise be overlooked.

The supply of fish in a given body of water should be maintained in so far as possible by the natural reproduction of the original stock and its progeny. If, however, intensive fishing is carried on, it may be advisable to make additional plants of fish. There is danger in introducing new species, especially the more voracious kinds, where desirable species are established. The competition for food may result disastrously for the native species without giving

FIG. 8.—Removing rescued fish from seines to tubs.

FIG. 9.—Holding fish in transportation cans in streams when necessary to delay planting. Ends of cans covered with mosquito bar.

anything in return. The supply of fish in streams may be increased also by the closing of small feeder branches that are suitable for small fish and by the temporary closing of main streams in rotation.

POLLUTION OF STREAMS.

The following information on the pollution of streams, adapted from the report of the New York Conservation Commission for 1922, will enable those interested in stocking public waters to decide whether the streams in which they are interested are polluted to the extent that fish could not survive therein:

Pollution of a stream by sewage and other organic wastes may injure fish by removal of gaseous oxygen dissolved in water. This dissolved oxygen is as necessary to fish as is oxygen of the air to the ordinary air-breathing animal; without it the fish suffocate.

Certain common and easily recognized water plants and animals show accurately the dissolved oxygen content of the water and can be considered as indicators of the degree of pollution of a stream.

Water in a state of chemical purity does not exist in nature. Water flowing in any stream carries in solution certain salts, gases, and other compounds and frequently various matter in suspension. Only by the presence of these materials can aquatic life exist.

Pollution may actually kill fish at some stages of development and not at others. It may be harmful to some species and not to others, and it may have effects in any degree of gravity. It may affect a small area or many miles in the length of a stream. Intensity of pollution, extent of the affected area, and the habits of the fish normal to the stream must all be considered.

Fish themselves are not always the best indicators of the condition of a stream. Failure to catch fish does not prove that a condition of serious pollution exists. Absence, real or apparent, may be explained by overfishing, invisibility, or failure to take the hook, or the fish may have gone elsewhere on their own affairs and not because of pollution. The small plants and animals present, which either can not move at all or can not move far, show the average stream condition better than do the fish.

Plants growing in clean water are markedly green and frequently of more highly organized types than those in polluted sections, and animal life tends to be more active and highly organized. Typical forms of animals and plants that will not inhabit polluted waters are shown in the following list:

Dobson or "Helgramite" (*Corydalis cornuta*, Linn). Larva. Three to four inches long. Under or around stones in swift water.

Stonefly (*Perla sp.*) Nymph. Under and around stones in swift water; very flat body with two "tails."

Caddis worm (*Hydropsyche sp.*) Larva of the caddis fly. Several species with various habits and forms; in swift waters mostly; under stones in loosely constructed pebble and webbing cases; attached to stones on the lee side of the current in compact stone cases, or in a funnel-like strainer of webbing with a retreat.

May fly (*Heptogenia sp.*) Nymph. Under stones in swift water; very flat body, smaller usually than stonefly; three "tails."

Dragonfly (*Anax junius*, Dru). Nymph. Extensible "lower jaw;" darts forward by expelling water from behind; found in dense growths of green aquatic plants in still water. Damselfly nymphs are similar, but have three long featherlike "tails."

Water penny (*Psephenus lecontii*, Lec.) Larva of a beetle. Common in swift water, clinging closely to underside of stones, occasionally at top or sides.
Fresh-water shrimp or "scud" (*Hyalella sp.*) Weedy portions of the stream; rapid swimmers; tail foremost.
Water net (*Hydrodictyon reticulatum* (L) Lagerh). A green alga of the pond areas of streams. When spread, it resembles a fine meshed veil; a remarkable oxygenator.
Water moss (*Hypnum riparium*). Attached to stones or gravel in swift streams.

Some species of plants and animals are of little value as indicators of pollution, because they are found in both clean and polluted waters. Snails, black-fly larvæ, water boatmen, and similar forms have a wide range and therefore are not good guides to water condition, except to the scientist who can distinguish the different species.

Indicators of pollution may be summed up thus:

Water molds and scums, particularly if of colors other than green, indicate decreasing oxygen—conditions are not favorable and may be worse downstream.

Tubifex (a small, slender, red earthworm) marks approximately the limit of fish life.

Rat-tail maggots, if abundant over the whole bed of the stream, are an almost certain indication of prohibited pollution.

Bloodworms indicate recovery and conversion of wastes into fish food.

Green plants, mosses, silks, and nets usually indicate good and improving conditions.

METHOD OF DISTRIBUTION.

In making distribution of fish consideration is first given to the waters from which the fish or fish eggs were collected, after which shipments are then made to suitable public or private waters upon applications previously submitted. Blanks on which formal requests for fish may be made are furnished by the bureau. These blanks call for a complete description of the waters to be stocked, and from this information are determined the species of fish that is suitable and the number that can be apportioned to the water area in question.

The bureau finds it impracticable to investigate the condition of all streams to determine their suitability for particular species of fish, although such a study would be highly desirable, as it would afford a basis for intelligent assignments. Since this is not practicable at present and the bureau is required to rely on information furnished by applicants, it is decidedly important that such information be as accurate and complete as possible.

Applicants are notified immediately upon receipt of their requests concerning the species assigned and the approximate date of delivery and are given full directions for receiving and caring for the fish. Before shipment is made a second notice is given, usually by telegram, stating the exact time of arrival of the fish at the railroad station. The fish are delivered at the station without expense to the applicants. In the event that it becomes necessary to delay shipment the applicant is notified accordingly.

The bureau frequently receives requests from applicants for the loan of cans to transport fish from the railroad station to the waters where they are to be planted. As many applicants fail to understand why such requests can not be granted the following explanation is given:

Live fish are usually forwarded by the bureau in carload lots to central points, the cars being specially equipped for this purpose. Detached messengers, however, leave the cars at predetermined points with shipments of fish for applicants who live off the main lines. These messengers travel in baggage cars of regular passenger trains, and many deliveries are necessarily made while the train makes its customary stops. The messenger often has as many as 15 and 20 deliveries to make before returning to the car and must promptly return his full equipment of cans in order to make other shipments in accordance with a prearranged schedule. As the cans are part of the car's equipment, it is obvious that were they loaned to applicants it would necessitate a suspension of distribution work until they were returned.

It should be borne in mind that while some of the State fish commissions, due to the proximity of their hatcheries to the waters where the fish are to be planted, are able to lend cans to applicants, such a course on the part of the bureau would seriously cripple its distribution work, since its equipment is required to make distributions from hatcheries located in different States.

Applicants are urged, therefore, to provide themselves with receptacles suited for carrying fish to the headwaters of streams, such receptacles to be in readiness at the railroad station as specified in the notice which is sent by the bureau's agent in advance of the shipment. They should be uncovered and empty on the platform where the car of this bureau or baggage car is expected to stop, for the fish must be transferred to the vessels quickly without delaying the train beyond the time it ordinarily stops. If no receptacles have been provided, the fish will not be delivered nor will they be delivered, even though receptacles are in readiness, unless the applicant or his representative is on hand to take care of them and sign the required receipt. Under no circumstances, therefore, will the bureau loan its distribution equipment to applicants, and unless due provisions shall have been made to receive and properly care for the fish they will not be taken from the train.

SIZE OF ALLOTMENTS.

In making allotments on applications the following items are taken into consideration: The area of water to be stocked as stated in the application, size and number of fish available for distribution, and distance the fish have to be transported. The bureau does not attempt to furnish applicants with more than a sufficient number of fish for a brood stock for a given body of water, and it expects these to be protected and allowed to reproduce.

SIZE OF FISH.

In its distribution of fish the bureau sends out certain species in the form of fingerlings or yearlings. This is especially true as regards brook and rainbow trouts. At certain stations, however, it is

necessary to distribute a portion of the product before this stage is reached in order to prevent overcrowding. The basses, bream, and other pond fishes are distributed from three weeks to several months after they are hatched. The last lots of bass shipped usually range from 4 to 6 and the sunfish from 2 to 4 inches in length. The commercial species, such as whitefish, trout, cod, pike. perch, etc., which are hatched in large numbers, are necessarily planted as fry. The basses, sunfishes, crappie, yellow perch, and other fishes rescued from the landlocked ponds and pools in the Mississippi Valley are from 3 to 6 inches in length when distributed. Eggs are distributed to State hatcheries and occasionally to applicants with the understanding that the resultant fry are to be planted in public waters.

PERIOD OF DISTRIBUTION.

Because of the increased cost of shipping fish, trips to distant points are postponed until there are a sufficient number of applications to warrant the expense. The bureau does not carry a stock of fish for delivery on demand, and when the supply of one year becomes exhausted it is necessary to wait until the next year's product is available to meet requests. The distribution of trout in the Eastern States is arranged early in March, and requests for trout submitted after March 1 are carried over until the following year. In the Rocky Mountain regions trout are distributed during the period extending from May to October, and applications should be filed with the bureau not later than May 1. Black bass, sunfish, crappie, etc., are supplied from May to November, and requests for those species should be filed prior to May 1, in order to receive attention before the following winter. It is the aim of the bureau to fill applications in the order of their receipt and to make delivery as soon thereafter as possible.

AERATION OF WATER.

When a large number of fish are confined in a receptacle, they soon consume the gaseous oxygen dissolved in the water, especially if the vessel is allowed to stand a while. It is important, therefore, that applicants receiving fish plant them as soon as possible. When the fish are carried in a vehicle, the splashing of the water serves to renew the supply of oxygen. This is true only when travel is over rough roads. Fish manifest their desire for oxygen by coming to the surface of the water. The water must be aerated, and a dipper should be provided for this purpose. Sufficient aeration may be accomplished by dipping the water and letting it fall from a height of about 2 feet, this process being repeated when the fish show signs of distress. *Fish should not be allowed to remain on the depot platforms, and, without expert knowledge in handling live fish, no attempt should be made to hold them overnight.*

Cool temperature is an important factor in holding fish, as the cooler the water the more gaseous oxygen it holds in solution. The proper temperature may be maintained by wrapping the containers in wet sacking or by placing ice in the cans.

PLANTING OF FISH.

When planting fish, sudden change in temperature should be avoided. This may be done by pouring some of the water from the cans and slowly adding water from the stream or lake in which the fish are to be deposited. The change of temperature should be gradual, not less than half an hour being consumed in modifying it 10°. In a stream it is best to deposit a few fish in each of several places as near as possible to the headwaters or in small tributaries. In lakes or ponds they should be scattered in shallow places where the water is not stagnant. Localities should be selected where the fish will have a supply of natural food and be immune from attacks of enemies.

COOPERATION WITH VARIOUS AGENCIES.

UNITED STATES FOREST SERVICE.

The major portion of fish distributed in Colorado, New Mexico, and Arizona is handled by forest rangers, who meet the consignments at railroad stations and carry the fish to the headwaters of streams. The method of keeping the headwaters of streams well stocked is productive of highly satisfactory results. The young fish are afforded suitable surroundings with abundance of natural food, they are free from the attacks of other fish, and they are, by virtue of the inaccessibility of the headwaters of many streams, out of reach of the angler. When the headwaters become overstocked, the large fish drop downstream in search of food, where they may be taken by anglers of the more populous districts. The idea of using the headwaters of streams as breeding and rearing grounds for the various species of trout is being followed wherever practicable. The plan possesses great possibilities and seems to be the only method whereby trout can be maintained in certain streams in view of the annual increase in the number of anglers.

NATIONAL PARKS.

Until within comparatively recent years the full possibilities of our national parks as fish preserves have not been given the serious consideration to which they are entitled. Realizing the necessity of maintaining a supply of fish in the waters of national parks, where fishing has become intensive during the open season, the bureau has established field stations in Yellowstone and Glacier Parks where skilled fish-culturists are temporarily detailed to make collections of and incubate the eggs of the various species of trout, the resultant fry being liberated in the waters most suitable for the particular species involved.

The National Park Service is now actively engaged in a most intensive campaign of fish-cultural development in cooperation with the bureau's hatcheries in Yellowstone and Glacier National Parks.

RAILROADS.

For a number of years the important railroads of the country have granted the bureau the privilege of carrying in baggage cars in passenger trains shipments of fish when accompanied by attendants,

the only requirements being that each attendant be provided with a first-class fare and the number of cans carried in a shipment be limited to 20. However, several railroads have recently volunteered free transportation for the bureau's distribution cars when engaged in planting fish in waters contiguous to their lines. The following extract from a letter received from the vice president and director of traffic of the Great Northern Railway is indicative of the attitude of one of the great railroad companies of the country toward this branch of the bureau's work:

ST. PAUL, MINN., *May 1, 1922.*

Mr. H. F. MOORE,
Acting Commissioner, Bureau of Fisheries, Washington, D. C.

DEAR SIR: We are very glad, indeed, to cooperate with your bureau in the development of fish culture in waters along our line. I am sure that the work done by your bureau is productive of much good at all points and is something that we feel should be encouraged. You may be assured in the future, as in the past, of our active cooperation at all times and thank you sincerely for writing me on the subject.

Yours very truly,

W. P. KENNEY.

The Oregon Short Line, Lehigh Valley, Pere Marquette, Michigan Central, Chicago, Milwaukee & St. Paul, Chicago & North Western, Chicago, Burlington & Quincy, Bangor & Aroostook, and the Maine Central are other railroads that have extended courtesies in the way of free transportation or reduced rates to the bureau's cars or to messengers in charge of living fish.

This cooperation demonstrates the value that the large railroad systems of the country place upon having the streams in the vicinity through which they pass well stocked with fish. Such streams not only afford pleasure for the tourist, but increase transportation over the roads and have a tendency to make such sections more attractive to settlers.

ORGANIZATIONS AND INDIVIDUALS.

Without the excellent spirit of cooperation shown by organizations and individuals and the valuable information received from anglers' clubs and others interested in fishing, the bureau, with its limited funds, could not undertake more than 75 per cent of the work it now accomplishes in interior waters. Although the bureau makes deliveries of fish at the railroad station of the applicant free of charge, the expense of hauling the consignment to suitable waters is no small item. This part of the cost is borne by the applicant, frequently an organization. Shipments of fish are sometimes met by 25 or 30 members of an organization and the consignment divided among them and planted in the waters most suitable for the particular species involved. These organizations are also of inestimable value in promoting sentiment for the enforcement of fisheries regulations and possibly serve to increase the supply of fish in streams by this more than by making plants of fish. The bureau desires to encourage the formation of such societies as will foster the supply of fish, and it is willing to render any advice that may be needed to attain that end. Applications for fish will be furnished such organizations when it is shown that the waters are in need of restocking.

FISH PROTECTION.

RESTRICTIVE FISHING LAWS ESSENTIAL.

It is obvious to everyone giving thought to the subject that unrestricted fishing, particularly in inland waters, can have but one result, namely, the complete disappearance of desirable fish. It is hardly probable that the most highly developed methods of artificial propagation, however intensively applied, can be made effective against the rapid growth of the country and the increasing numbers of anglers unless such work is supplemented by natural reproduction. This implies restrictive laws on fishing and the development of a public sentiment in favor of such laws and their enforcement. The following suggestions embody a few of the more important points for consideration in connection with fish protection. It is hardly possible to frame laws that can be applied generally. Each section of the country will find it necessary to modify the laws to meet existing local conditions.

As an earnest of good faith on his part—that he respects the fishing laws and intends to observe them—the prospective fisherman before starting on his trip should obtain from the State fisheries authorities a license to fish. If we are to protect any species of animals such protection must be extended to the young. Therefore a size limit on the fish that may be legally taken is unquestionably essential. If natural reproduction is to reach its highest value, fish must not be molested during their mating season. The true sportsman on his fishing trip is not seeking a large number of fish, but rather recreation in the open, and it is unsportsmanlike to take more fish at one time than can be properly used. This idea suggests the desirability of limiting the number of fish that may be legally taken in any one day. Angling is recognized as one of the most popular sports, but it is not sportsmanlike to take fish by other than sportsmanlike methods, which usually implies a rod and line held in the hand. The use of poisons or explosives and the shooting of fish are always reprehensible. The wanton obstruction of the free passage of fish in any stream, the deposit therein of trade or other industrial wastes injurious to fish, the operation of irrigation ditches without screening them for the exclusion of fish, all of these practices are prolific causes of unnecessary depletion of fish life in inland waters. In streams across which dams have been erected for industrial purposes fish will frequently congregate in considerable numbers at certain seasons of the year. To take them from such places by spearing, gaffing, or other means is obviously not sport but wanton destruction.

ENFORCEMENT OF FISHERIES LAWS.

The bureau has no jurisdiction in the enforcement of fisheries regulations excepting in Alaska and in respect to the sponge fisheries beyond State limits in the Gulf of Mexico, such matters coming under the State governments. If the fish and game laws are not enforced, the matter should be taken up with the proper officials of the State in which the violations occur. The bureau will not knowingly furnish fish for waters in which illegal fishing is unchecked. The matter of stream pollution and that of providing adequate fishways should also be taken up with the State fisheries authorities.

EXTERMINATION OF PREDATORY ANIMALS AT BUREAU'S STATIONS.[4]

Birds.—Traps placed on small platforms on stakes driven around the pond are used at a number of the bureau's stations for the capture of kingfishers, but these as well as the fish hawk, heron, fish duck, mud hen, water ouzel, and all other feathered enemies of fish life can be successfully held in check by the use of firearms.

Mink.—These animals may be taken either on land or in the water by means of a trap set on a projecting point of the bank, or in the water at places where the signs indicate that they come for fish. A mink will wander all along the banks of a stream or pond, exploring every nook, including all the little brooks and ditches emptying into it. The traps are therefore often set on fallen trees or logs across small streams. Bait is sometimes used. For this purpose the entrails of a bird or other animal are more satisfactory than the whole body, and a decayed fish is still better. Mink are believed to feed principally on fish.

Frogs.—There is some doubt as to whether frogs eat live fish and fish eggs. It is safe to say, however, that frogs under 1 year of age are not detrimental to fish. Frogs may be dipped from a pond by means of a net fastened to a long pole, or they may be killed by spearing.

Snakes.—Water snakes are perhaps the worst enemies of fish and should be killed by whatever method possible. Their depredations may be considerably lessened by keeping the ponds and streams clear of brush and débris.

Muskrats.—Trapping is the most practicable means of checking the inroads of muskrats, and if persisted in by a trapper of some skill their depredations may be stopped. For this purpose a No. 1 steel trap with a long chain of wire attached is the most suitable. It is usually best to set it half an inch to an inch under water, below the niches or shelves along the banks where the animals feed, as will be indicated by remains of roots and partially eaten stems of plants. The chain should be securely fastened to a stake driven as far out in the water as possible. When set in shallow water, the rat will be likely to twist off a leg and escape; but if deep water is accessible, it will try to escape by diving, and if there is plenty of chain it will soon drown. The trap may also be set under water in the trails or runways, on logs or boards sloping into the water, in burrows in the banks, or on the bottom of the pond at the entrance to a burrow, under the nest chambers of the houses. It is rarely necessary to bait the trap, though a slice of carrot or turnip will sometimes attract the animals. Where they are numerous a gun may be used at first, but they soon become timid and distrustful, making this impracticable. Poisoning appears not to have been resorted to in the case of muskrats, perhaps because of the attendant danger to other animals and because the dead rats pollute the water.

Turtles.—The most effective way of removing turtles from a pond or lake is to draw off the water and collect them in hand nets. If this is not practicable, a pole about the size of a telegraph pole may be placed slantwise in the water, at a point where the depth is from

[4] Advice given here is not to be taken as authority for killing animals protected by State laws.

4 to 6 feet, in such a position that its upper end projects about a foot above the surface. Stretch a net around the pole on all sides, except the one where the turtles would be most likely to crawl out of the water, adjusting it to form a pocket under the slanting end of the pole and fastening it with four or five stakes driven into the mud. A sudden approach in a boat will cause the turtles to drop off into the net, when they can be easily captured. Turtles, however, with the exception of the snapping turtle, are not considered very destructive of fish life. The latter can easily be captured by hook and line, baited with a piece of fish and secreted in the weeds where the fish can not find it.

Undesirable fishes.—Undesirable fishes that may gain entrance into a pond can be removed by hook-and-line fishing. Eels are caught in the same manner and also with special traps made like the old-fashioned lobster pot. In removing carp, if the conditions will permit, it is preferable to lower the water in the pond and use a seine. While this is being done the desirable fishes can be held in a retaining tank and returned to the pond after it is refilled.

RESULTS OF STOCKING INTERIOR WATERS.

During the period extending from 1899 to 1915, inclusive, 15,294 reports from applicants were recorded, the general results being as follows: Excellent, 1,581; good, 7,730; fair, 1,681; overflow, 428; uncertain, 916; and poor, 2,741. Eighteen per cent of the reports covering this period indicate poor results. This is attributable in a great measure to the early methods, necessarily experimental, of handling requests for fish.

Within recent years the bureau has developed a system of distribution by which the liability of making unsuitable assignments of fish is rendered remote. Many failures in the past have been due to placing black bass in small ponds. It is found from experience that this species will not produce satisfactory results in a body of water of less than 2 acres in area. Crappie, bream, and rock bass are now assigned for the smaller water areas, and it is evident from the reports received that such assignments are productive of very favorable results.

COMPARATIVE RESULTS FOR CERTAIN PERIODS.

The following table shows the comparative results of plants made during the periods from 1899 to 1915 and from 1916 to 1917. The improved method of handling requests for fish is believed to have been an important factor in the more successful results obtained in 1916 and 1917. Explanations, with comments, of terms used in this table and in the table below it follow.

Excellent means that the fish increased in size and multiplied. *Good* is used where the applicant was satisfied, the fish having attained a large size and the number apparently being on the increase. *Fair* means that the results were only ordinary, many of the applicants using this word merely to express the results of the plants. *Overflow* is used where the dam of the pond broke and the fish escaped. This does not mean a loss of the fish, as in many instances the statement is made that certain streams were stocked by the breaking of dams. *Uncertain* is used where the applicant is undecided as to the results. Most of the reports classified under this heading cover plants of fish made in

large streams and lakes where it was found difficult to determine whether the fish furnished by the bureau had actually produced results, owing to the fact that the waters had been previously stocked with the same species. *Poor* covers reports that indicate that the plants were a failure. Failures are attributed to a number of causes, as follows: Unsuitability of the waters, poor condition of the fish when received, destruction of the fish by snakes and other predatory animals. Many failures are attributed to the severe winter of 1916 and 1917, when ponds froze to an unprecedented depth. In some instances the fish were stolen.

Period.	Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1899–1915	10.5	51	11.5	3	6	18
1916–1917	30.6	42	12.5	2.2	6.2	6.5

DETAILED RESULTS FOR 1916 AND 1917.

The following table shows the detailed results of fish planting during the fiscal years 1916 and 1917, based on 4,589 reports received from individuals and organizations. This table does not cover shipments of fish made to agents of the United States Forestry Service. To economize space no tabular statement is presented for the period from 1899 to 1915. The preceding table, however, for the years 1916 and 1917 is fairly representative of the bureau's normal activities.

Results of fish planting during fiscal years 1916 and 1917, shown by States and species.

[For explanation of headings see p. 111.]

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Alabama:							
Catfish	4		2		2		
Rainbow trout	2		1			1	
Brook trout	1			1			
Crappie	8	2	3	2		1	
Large-mouthed black bass	94	35	36	7	6	6	4
Small-mouthed black bass	3		2				1
Rock bass	4	1	3				
Sunfish	90	15	37	16	10	4	8
Arizona:							
Catfish	5	1	4				
Rainbow trout	5		3			1	1
Black-spotted trout	2			2			
Brook trout	3	1	2				
Crappie	2		2				
Large-mouthed black bass	8	1	6		1		
Sunfish	1		1				
Arkansas:							
Catfish	9	5	2	2			
Rainbow trout	3	1	1	1			
Crappie	4	1	2		1		
Large-mouthed black bass	48	14	23	3	3	5	
Small-mouthed black bass	4	1		1		2	
Rock bass	8			3	1	1	3
Sunfish	21	5	3	4	2	2	5
California:							
Rainbow trout	2		2				
Large-mouthed black bass	1	1					
Sunfish	2	1				1	
Colorado:							
Catfish	2						2
Rainbow trout	42	12	27	3			
Black-spotted trout	164	36	113	14		1	

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Colorado—Continued.							
Lake trout	1	1					
Brook trout	87	12	52	19	1		3
Grayling	4	2	1			1	
Crappie	1		1				
Large-mouthed black bass	16	2	9	3			2
Rock bass	1		1				
Sunfish	3		3				
Connecticut:							
Steelhead salmon	1		1				
Brook trout	25	9	9	5		1	1
Large-mouthed black bass	8		6	1		1	
Small-mouthed black bass	2		1			1	
Sunfish	1		1				
Pike perch	2			1		1	
Yellow perch	1		1				
Delaware:							
Brook trout	2		1				1
Large-mouthed black bass	3		3				
Florida:							
Crappie	1						1
Large-mouthed black bass	26	2	19	2	1	1	1
Sunfish	1					1	
Georgia:							
Catfish	1						1
Rainbow trout	3		1	2			
Brook trout	1				1		
Crappie	6	1				3	2
Large-mouthed black bass	38	11	16	2	3	5	1
Small-mouthed black bass	1					1	
Rock bass	1			1			
Sunfish	17	3	5	3	3	1	2
Idaho:							
Rainbow trout	6		2		1	1	2
Black-spotted trout	3	2	1				
Brook trout	3		2				1
Grayling	1	1					
Illinois:							
Brook trout	1						1
Crappie	15	2	7	4	1		1
Large-mouthed black bass	9	4	2	1		1	1
Small-mouthed black bass	5	1	2	1		1	
Rock bass	3	2	1				
Sunfish	1				1		
Pike perch	1	1					
Indiana:							
Catfish	5	1	3	1			
Rainbow trout	3		1	1		1	
Brook trout	1					1	
Crappie	9	2	4	1		1	1
Large-mouthed black bass	38	8	21	3	3	2	1
Small-mouthed black bass	29	5	19	1	1	1	2
Rock bass	13	2	2	3		4	2
Sunfish	10	1	3	3	1	2	
Pike perch	7	1	3	1		1	1
Iowa:							
Catfish	2	1					1
Rainbow trout	2	1		1			
Crappie	3		2	1			
Large-mouthed black bass	5	1	3			1	
Sunfish	2				2		
Pike perch	1				1		
Kansas:							
Crappie	1		1				
Large-mouthed black bass	10	6		3			1
Kentucky:							
Catfish	1	1					
Rainbow trout	1		1				
Crappie	18	2	7	3	1	1	4
Large-mouthed black bass	61	11	29	9	1	7	4
Small-mouthed black bass	12	2	2	4		1	3
Rock bass	13	2	6	2		1	2
Sunfish	7	2	1	1	1	1	1
Louisiana:							
Catfish	1		1				
Crappie	8		2	2	2	2	
Large-mouthed black bass	8	2	5	1			
Sunfish	4		3				1

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Maine:							
Steelhead salmon	2					2	
Landlocked salmon	9	1	6	2			
Lake trout	1		1				
Brook trout	39	11	25	1		2	
White perch	3		1			2	
Maryland:							
Catfish	1		1				
Rainbow trout	5	3	1			1	
Brook trout	12		10	2			
Large-mouthed black bass	18	1	9	4		3	1
Small-mouthed black bass	2		2				
Massachusetts:							
Catfish	2	1	1				
Landlocked salmon	3		2				1
Rainbow trout	2					1	1
Brook trout	27	11	12	3		1	
White perch	2			1		1	
Minnesota:							
Rainbow trout	8	4	2		1	1	
Lake trout	2		2				
Brook trout	11	4	4			2	1
Crappie	2		2				
Pike perch	5	3		1		1	
Michigan:							
Catfish	12	2	5	4		1	
Steelhead salmon	7	1	4			2	
Rainbow trout	10	3	4			2	1
Lake trout	2					1	1
Brook trout	62	24	27	3	1	5	2
Grayling	1			1			
Crappie	9	2	4	1		2	
Large-mouthed black bass	56	21	33	1		1	
Small-mouthed black bass	129	47	57	4	2	9	10
Rock bass	1	1					
Sunfish	8	5	1	1		1	
Pike perch	13	8		1		3	1
Yellow perch	4		2	1		1	
Mississippi:							
Catfish	5	1	3	1			
Buffalo fish	1		1				
Crappie	47	21	11	7	2	3	3
Large-mouthed black bass	54	26	14	5	3		6
Sunfish	17	5	5	4	1	1	1
Missouri:							
Catfish	12	2	1	7		1	1
Buffalo fish	1	1					
Rainbow trout	24	11	5	3		3	2
Crappie	32	14	5	10		2	1
Large-mouthed black bass	64	34	18	10			2
Small-mouthed black bass	7	2	2			2	1
Rock bass	4	3	1				
Sunfish	24	6	6	8		1	3
Pike perch	3	3					
Yellow perch	3	1		1			1
Montana:							
Catfish	4	3				1	
Steelhead salmon	2					1	1
Rainbow trout	78	18	24	29		4	3
Black-spotted trout	100	53	29	9		5	4
Brown trout	1	1					
Brook trout	119	34	63	17		3	2
Grayling	3	2	1				
Rock bass	1			1			
Sunfish	3	1		2			
Yellow perch	1	1					
Nebraska:							
Catfish	1			1			
Rainbow trout	9	6	2	1			
Brook trout	17	5	8	4			
Crappie	4			2			2
Large-mouthed black bass	4	2	1				1
Sunfish	1			1			
New Hampshire:							
Catfish	3	1	1			1	
Steelhead salmon	1					1	
Landlocked salmon	8	3	3	1		1	
Rainbow trout	20	5	3	4		3	5

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
New Hampshire—Continued.							
Lake trout	6	1	2			1	2
Brook trout	150	79	58	6		4	3
Crappie	1			1			
Large-mouthed black bass	3	3					
Small-mouthed black bass	1			1			
Yellow perch	2	1				1	
White perch	3		1			1	1
New Jersey:							
Rainbow trout	1			1			
Brook trout	10	3	5	1			
Large-mouthed black bass	13	4	6	1			2
Small-mouthed black bass	10	7	1			2	
Rock bass	1	1					
Sunfish	1						1
Yellow perch	1	1					
New Mexico:							
Catfish	4	1	2				1
Rainbow trout	3	2	1				
Black-spotted trout	4	2	2				
Brook trout	2	2					
Large-mouthed black bass	11	4	4	2		1	
Sunfish	8	1	2	2		1	2
Yellow perch	2		1			1	
New York:							
Catfish	4	2	2				
Steelhead salmon	1		1				
Landlocked salmon	4	1	3				
Rainbow trout	11	4	3			4	
Lake trout	5	1	2	2			
Brook trout	62	35	17	5		3	2
Crappie	3			2		1	
Large-mouthed black bass	21	9	9	2		1	
Small-mouthed black bass	15	2	4	6	1	2	
Rock bass	4		1	1	1	1	
Sunfish	6	2	1				3
Pike perch	21	7	7	1		3	3
Yellow perch	2	1					1
White perch	2					2	
North Carolina:							
Rainbow trout	15	3	6	1	3	1	1
Brook trout	9	2	5		1	1	
Crappie	2	2					
Large-mouthed black bass	26	5	6	8	6	1	
Rock bass	3			2		1	
Sunfish	5		1		1		3
North Dakota:							
Catfish	2			1		1	
Rainbow trout	1						1
Crappie	5	1	2			1	1
Large-mouthed black bass	9	1	3	3			2
Rock bass	1			1			
Pike perch	1			1			
Yellow perch	1						1
Ohio:							
Catfish	4	1		1		1	1
Rainbow trout	9	3	1	1		2	2
Brook trout	1						1
Crappie	9		1	6		1	1
Large-mouthed black bass	28	5	17	6			
Small-mouthed black bass	22	6	3	11		2	
Rock bass	2		2				
Sunfish	5	2	1	2			
Pike perch	3		2			1	
Yellow perch	3	2					1
Oklahoma:							
Catfish	1	1					
Crappie	10	2	4	1	1	1	1
Large-mouthed black bass	18	5	11		1		1
Rock bass	4			1	1	1	1
Sunfish	8	2		2	2		2
Pennsylvania:							
Catfish	33	9	13	6		1	4
Rainbow trout	181	55	69	19		16	22
Brook trout	532	189	221	43		18	61
Crappie	6	2	2			1	1
Large-mouthed black bass	96	31	45	10		5	5
Small-mouthed black bass	72	27	29	11		4	1

Results of fish planting during fiscal years 1916 and 1917, shown by States and species—Continued.

State and species.	Number of reports.	Increase and growth.					
		Excellent.	Good.	Fair.	Overflow.	Uncertain.	Poor.
Pennsylvania—Continued.							
Rock bass	7	2	2	2			1
Sunfish	25	5	14	3	1	2	
Pike perch	14	9	1	3			1
Yellow perch	5	1	2	1			1
Rhode Island: Brook trout	1		1				
South Carolina:							
Catfish	3	1	1	1			
Rainbow trout	4	2	1	1			
Brook trout	1	1					
Crappie	2			1			1
Large-mouthed black bass	39	4	16	8	4	3	4
Sunfish	6			5			1
South Dakota:							
Catfish	3		3				
Steelhead salmon	1					1	
Rainbow trout	16	1	12	2		1	
Black-spotted trout	11	5	5		1		
Loch Leven trout	6	2	3			1	
Brook trout	27	6	18	2	1		
Crappie	4		2	1		1	
Large-mouthed black bass	5	2	1	1		1	
Pike perch	1			1			
Tennessee:							
Rainbow trout	15	2	6	4		1	2
Brook trout	3	1	1	1			
Crappie	5		5				
Large-mouthed black bass	18	4	9	3			2
Small-mouthed black bass	1		1				
Vermont:							
Steelhead salmon	4	2		2			
Landlocked salmon	4	3	1				
Rainbow trout	2		2				
Lake trout	2		2				
Brook trout	156	62	83	2		2	7
Large-mouthed black bass	4		1	2			1
Small-mouthed black bass	7	1	4			1	1
Pike perch	16	7	3	1		3	2
Yellow perch	6	2	2			1	1
White perch	1					1	
Virginia:							
Catfish	2		2				
Rainbow trout	54	3	21	15	2	5	8
Brook trout	9	2	3	3			1
Crappie	7	1	3	2			1
Large-mouthed black bass	23	1	8	7		4	3
Small-mouthed black bass	4		2	1	1		
Rock bass	5		2	2	1		
Sunfish	2			2			
Yellow perch	1						1
Washington:							
Rainbow trout	6	3	1	1		1	
Black-spotted trout	1	1					
Brook trout	2	1	1				
West Virginia:							
Catfish	1					1	
Rainbow trout	7	2	4	1			
Brook trout	9	7	2				
Crappie	2	1	1				
Large-mouthed black bass	7	1	4	1		1	
Wisconsin:							
Steelhead salmon	1					1	
Rainbow trout	37	9	19	7		1	1
Lake trout	2	1				1	
Brook trout	127	30	86	6	1	2	2
Crappie	9	1	3	4	1		
Large-mouthed black bass	36	10	23			2	1
Sunfish	1	1					
Pike perch	9	4	3			1	1
Wyoming:							
Rainbow trout	2	2					
Black-spotted trout	3	2	1				
Brook trout	2	1	1				
Large-mouthed black bass	1	1					
Total	4,589	1,400	1,938	574	92	278	307

DEPARTMENT OF COMMERCE.

HERBERT HOOVER, Secretary of Commerce.

BUREAU OF FISHERIES.

[HENRY O'MALLEY, Commissioner.]

Chief functions.—Propagation of useful food fishes, including lobsters, oysters, and other shellfish, and their distribution to suitable waters.

Investigations relating to fish culture, fish diseases, conservation of fishery resources, and development of commercial fisheries.

Study of methods of fisheries and fishery industries and utilization of fishery products.

Collection of statistics of fisheries.

Administration of Alaska salmon fisheries, Pribilof Islands fur-seal herd, and law for protection of sponges off Florida coast.

BUREAU OF NAVIGATION.

[D. B. CARSON, Commissioner.]

Chief functions.—General superintendence of commercial marine and merchant seamen.

Supervision of registration, licensing, numbering, etc., of vessels under the United States flag and annual publication of list of such vessels.

Enforcement of navigation and steamboat inspection laws and laws governing radio communication, as well as duties connected with fees, refunds, taxes, fines, etc., originating under such laws.

COAST AND GEODETIC SURVEY.

[E. LESTER JONES, Director.]

Chief functions.—Survey of coasts of United States and Territories and publication of charts. Among other things, this includes base measure, triangulation, topography, and hydrography; deep-sea soundings, temperature, and current observations; magnetic observations and researches; gravity researches, etc.

Publications of results of this work in annual reports and special publications, including charts of coasts and harbors. Tide tables are published annually in advance, as well as other information of use to navigators.

BUREAU OF THE CENSUS.

[WILLIAM M. STEUART, Director.]

Chief functions.—Decennial census covering population, agriculture, manufactures, mines and quarries, and forest products.

Decennial report on wealth, public debt, and taxation.

Decennial statistics relating to inmates of institutions, including paupers, insane prisoners, and juvenile delinquents.

Census of agriculture in each middecennial year, biennial census of manufacture, quinquennial census of electrical public utilities, statistics of marriage and divorce.

Annual financial statistics of State and municipal governments.

Annual statistics of births, deaths, causes of death, etc., in the registration area of the United States.

Quarterly statistics of leaf-tobacco stocks and of production, stocks, and consumption of fats and oils.

Monthly or semimonthly statistics of cotton ginning, cotton stocks and consumption, the production, stocks, and consumption of hides and leather, the production of shoes and of active textile machinery.

Compilation and publication, in Survey of Current Business, of monthly commercial and industrial statistics.

BUREAU OF STANDARDS.

[GEORGE K. BURGESS, Director.]

Chief functions.—Custody of standards adopted or recognized by the Government.

Construction of standards, when necessary. Testing and calibration of apparatus and comparison of standards used by scientific or other institutions with those in custody of bureau.

Determination of physical constants and properties of materials.

Testing of materials and establishment of standards and processes in cooperation with commercial firms or organizations.

Collection and dissemination of information showing approved methods in building, planning, and construction, including building materials and codes and such other matters as may encourage, improve, and cheapen construction and housing.

Studies on simplified commercial practices and establishment through cooperative business organizations.

BUREAU OF LIGHTHOUSES.

[GEORGE R. PUTNAM, Commissioner.]

Chief functions.—Establishment and maintenance of lighthouses, lightships, buoys, and other aids to navigation on sea and lake coasts and rivers of the United States, including Alaska, Hawaiian Islands, and Porto Rico.

Publication of Light Lists, Buoy Lists, and Notices to Mariners, including information regarding all aids to navigation maintained by Lighthouse Service.

STEAMBOAT INSPECTION SERVICE.

GEORGE UHLER, Supervising Inspector General.]

Chief functions.—Inspection of vessels, licensing of officers of vessels, and administration of laws relating to such vessels and their officers. Certification of able seamen who form crews of merchant vessels.

Inspection of vessels, including hulls, life-saving equipment, and types of boilers; testing of all materials subject to tensile strain in marine boilers.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

[JULIUS KLEIN, Director.]

Chief functions.—Compilation of timely information on world market conditions and openings for American products in foreign countries secured through commercial attachés and trade commissioners of Department of Commerce and foreign service of Department of State.

Distribution of such information to American business through weekly Commerce Reports, special bulletins, confidential circulars, and the news and trade press.

Maintenance of commodity, technical, and geographical divisions in Washington to afford special service to American export industries.

Compilation and distribution of names of possible buyers and agents for American products in all parts of the world and publication of weekly lists of specific sales opportunities abroad.

Maintenance of 33 district and cooperative offices in 33 cities in the United States to expedite delivery of market information to business men and to keep department advised as to more urgent requirements of American trades and industries.

Publication of official statistics on imports and exports of the United States.